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Project NY 113 001-6
Technical Memorandum M-106

DEVELOPMENT OF AN IMPROVED PONTOON SYSTEM

3 August 1955

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u. s.
naval
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research
and
evaluation
laboratory

port hueneme,
california

U. S. Naval Civil Engineering Research and Evaluation Laboratory
Port Hueneme, California

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DEVELOPMENT OF AN IMPROVED PONTOON SYSTEM

3 August 1955

W. R. Mason
R. C. Towne

SUMMARY

An improved pontoon system, which is comparable both structurally and operationally to the present design, was developed at the U. S. Naval Civil Engineering Research and Evaluation Laboratory under Project NY 113 001-6, formerly NY 112 006. The improved design is less costly, easier to fabricate, requires fewer parts, and is more quickly assembled. This development started with an analysis of the present pontoon gear and a study of manufacturing problems and costs. As a result of these analyses and studies, the new design was developed, fabricated, and tested. The new design is not interchangeable with the present gear; however, a detailed study was made as to the feasibility of making it interchangeable. The results of this study led to the conclusion that interchangeability is not feasible nor a necessity, and it would be possible to introduce a new non-interchangeable pontoon system while present stocks are being reduced to a minimum by regular issue.

It is recommended that: (1) an in-service evaluation of a new 3 x 12 ramp barge of the improved design be accomplished at ACB No. 1; (2) accessory items be developed to complete the design; and (3) detailed plans and manual be prepared.

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ILLUSTRATIONS

figure page

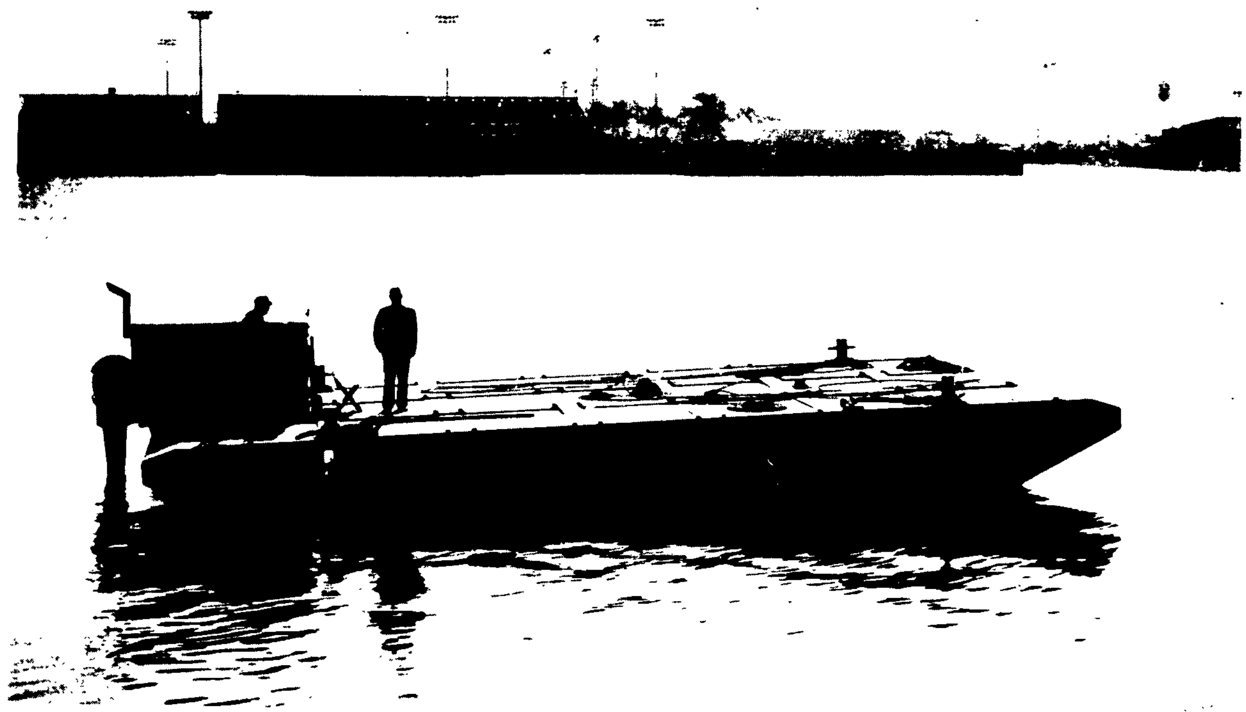

Figure 1. One 3 x 7 barge of the P-1, P-2 new pontoon gear design.

INTRODUCTION

The standard NL pontoons and accessory equipment were developed during the early part of 1942 and were utilized successfully in World War II. Postwar investigation was confined to improving and testing various assemblies of the pontoon gear.[1-8] The basic design of the pontoon and pontoon assemblies was not examined until June 1953, when the Laboratory initiated a study of the original design. This included consideration of fabrication, assembly, and operation of the pontoon gear and the effectiveness of various accessories. Development of an improved design followed as a result of these studies (see Figure 1).

INITIAL STUDIES

An investigation was started on the items which appeared to be costly and of questionable value to the structural integrity of the pontoon assemblies.

Pontoon Jewelry

First consideration was given to the pontoon jewelry, Mark A3, A4, and A5 shown in Figure 2, for the following reasons: (1) an early postwar study and design[6,7] resulted in one-piece jewelry; however, manufacture and test proved the design to be several times more expensive than the three individual pieces; (2) tests at Davisville, Rhode Island,[1] in 1945 and at Port Hueneme[2] in 1946-47 indicated that the jewelry had little effect on the load-carrying capacity of a pontoon string. In these tests, the angles and corner straps of the pontoons failed before the A6 bolts. A quotation from the report states, "A6 bolts alone will withstand a shearing stress equal to, or greater than, the steel corner plates of the pontoons"; (3) a test at NAVCERELAB[2] indicated no serious damage to a crane barge from omission of the jewelry; and (4) discussions with field personnel revealed that the jewelry in barges

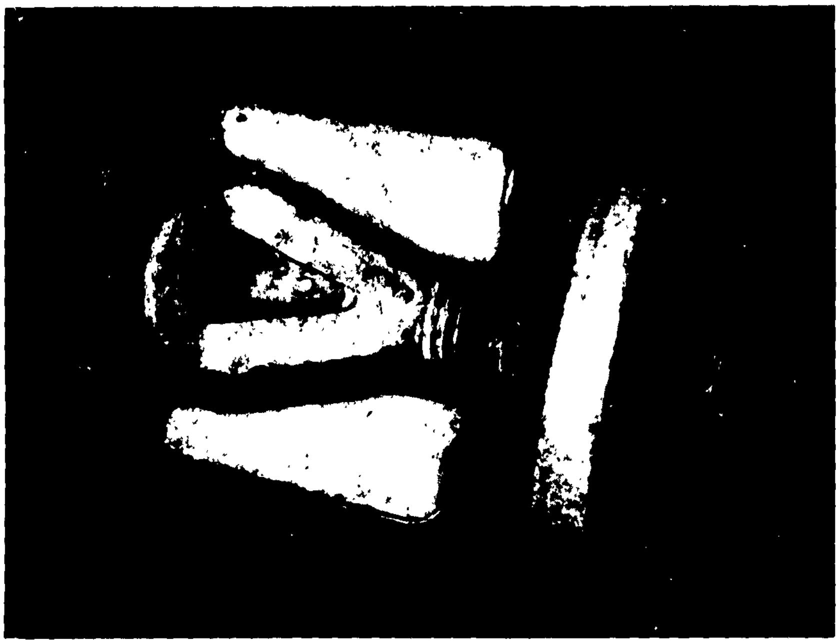

Figure 2. View of pontoon jewelry.

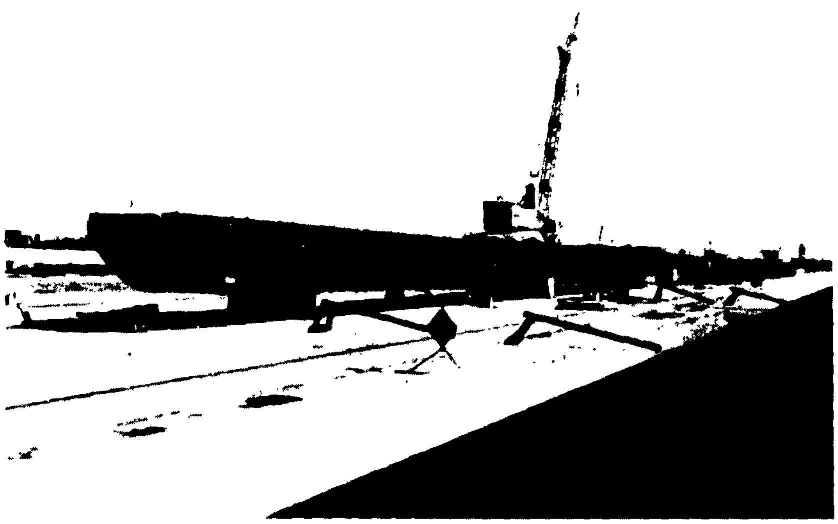

Figure 3. Static load tests viewed in process on 1 x 24 standard pontoon string with jewelry.

and causeways continually loosened and fell out during launchings and operations.

The investigation was started with a static load test, with and without jewelry, of a standard 1 x 24 pontoon string supported as a beam on a 100-ft span as illustrated in Figure 3. The results of these tests[9, 10] verified the Laboratory's suspicion that the jewelry did not add to the load-carrying capacity of the pontoon assembly.

The static load test still left some doubt as to the integrity of pontoon structures subjected to dynamic action such as wave motion and LST side-launchings when the jewelry was omitted. To determine the effect of dynamic action, a 5 x 14 barge (used in conjunction with the anchor tests at San Francisco) was assembled without jewelry and towed from Port Hueneme to San Francisco Bay in moderate seas, where it was used for a period of 14 months and then it was towed back to Port Hueneme without any damage or maintenance. Further, dynamic studies[11] which were made by side-launching a 3 x 12 barge, assembled without jewelry, five times from the height of the Class 1156 LST revealed no damage attributable to omission of the jewelry.

Pontoon Size and Shape

The size of the T6B pontoon, 5- by 5- by 7-ft, was studied from manufacturing, handling, shipping, and assembling points of view. In the review of the concept of the original design, it was found that the selection of this size was well founded. In the early part of World War II, shipyards and port facilities being overcrowded, it was decided that a size of pontoon that could be manufactured in small, steel-fabricating plants having limited equipment and located throughout the United States, and that could be shipped easily via rail or truck, would greatly accelerate the build-up program. It was decided that an approximate one-ton weight would also facilitate field-assembly with small-capacity handling equipment.

The T7A pontoon shown in Figure 4 was designed with a specially curved bow plate, based on information obtained from the Dravo Corporation, Pittsburgh, Pennsylvania, relative to the most efficient shape of hull designs. The 3/8-in. bow plate was used because the bow and stern of the barge receive the most abuse. The curved shape, however, made fabrication difficult and costly.

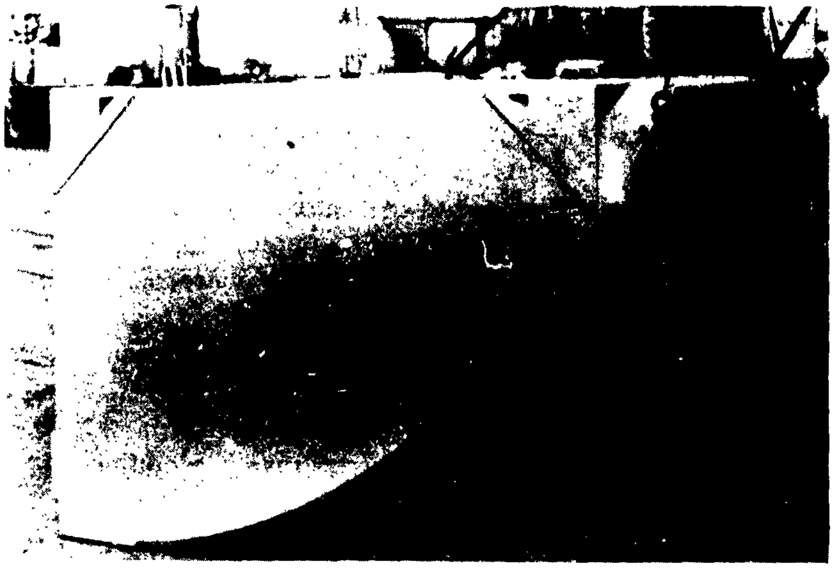

Figure 4. T7A pontoon.

Figure 5. T8 and T11 pontoons forming slope from T6B pontoon to beach.

An investigation of the T8 and T11 pontoon designs shown in Figure 5 revealed that a ramp from the deck of a barge or causeway to the beach was found necessary in the early part of World War II. Initially, a T7A was inverted, and a long wooden ramp was used from part way down the pontoon slope to the beach (see Figure 6).

Figure 6. Inverted T7A pontoon with wood ramp.

Because this ramp was heavy, difficult to handle, and easily damaged, the T8 and T11 pontoons were developed, and a short wooden ramp was used from the end of the T11 to the beach. This procedure proved effective and is used at present in place of the inverted T7A and long ramp, but further study (see Appendix I) indicated that the T8 and T11 were difficult and costly to fabricate.

The thickness of the plate used for the shell of the pontoons appeared adequate for their use and intended life.

Assembly Angles

The 26 types of angles now shown in the "Pontoon Manual," dated 1 November 1952, are the result of many additions to meet changing requirements of various sizes of pontoon structures. Additional types of angles probably will be necessary to meet future requirements.

One part of the angle design which was studied closely was the breech plug splice (see Figures 7 and 8). This splice was originally intended to join angles together without field-welding. However, in order to develop the strength of the joint, it was necessary to field-weld a tapered plate (fishplate) across the splice. As the use of the pontoons became more extensive, and more uses were found, field-welding became a necessity for ramps, propulsion-unit foundations, etc. Paralleling this need, welding became more universally used and more skilled welders became available, so the need for field-assembly without welding became less and less a requirement, until today it is no longer considered a requirement.

Structurally, the rectangular link and pin holes in the angles between pontoons severely penalized the angles at the critical sections (see Figure 9). An engineering appraisal of the link and pin (Figure 10) showed that they were of little structural value, the link having only 1.0 sq in. of metal in shear and tension, and the pin only 1.5 sq in. of metal in shear. Further, it was determined by test that they were not necessary for the assembly of strings of pontoons, if P-5 plates and the assembly clamp shown on Y&D Drawing 146,272 were utilized.

Accessories

Other items studied were the tie rods,[12] landing ramps, drydock piping,[13] propulsion-unit foundations, heavy-duty hinges, bitts, chain plates and deck closures. It was determined that P-5 plates should be utilized on the bottom of pontoon structures in place of the tie rods, wherever possible. The landing-ramp double hinge was found to be very effective, but the heavy wooden ramp (1300 lb) was cumbersome to handle and expensive. A short review of the drydock piping indicated some improvement could be made in the swing pipe and in standardization of the air piping. The heavy-duty

Figure 7. Male section of angle breech plug splice.

Figure 8. Female section of breech plug splice.

Figure 9. Rectangular link and pin holes located between the wedge bars on standard pontoon angle.

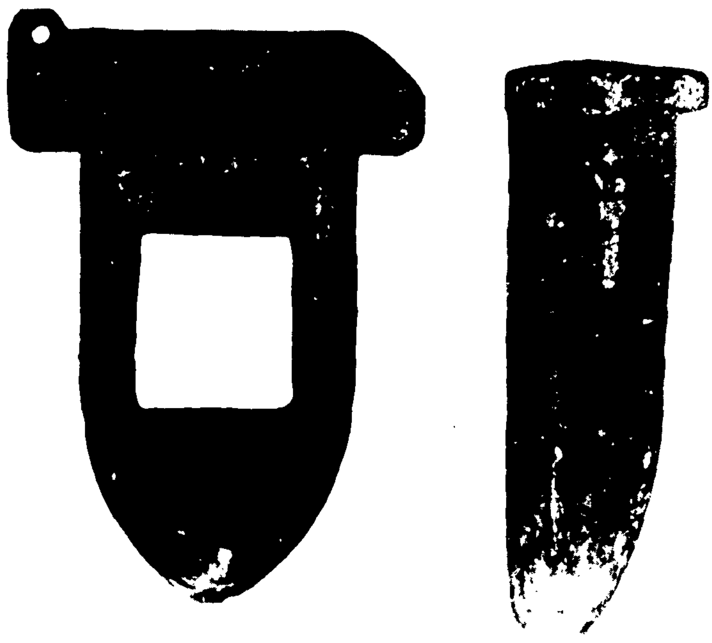

Figure 10. Link and pin.

hinge was studied and found adequate, but the drawings have some discrepancies. The deck closures were heavy and cumbersome.

COST AND MANUFACTURING CONSIDERATIONS

The Laboratory gave special attention, as in the engineering appraisal of any design, to the manufacture of the pontoons for the industrial aspect is of utmost importance if economy is to be achieved. This appraisal included a survey of availability of raw materials, manufacturing methods and techniques, and fabrication problems encountered by past and present pontoon manufacturers.

Raw Materials

The pontoons T6B, T7A, T8, and T11 are constructed of: 3/16-in. plate, 3/16-in. raised pattern plate, 3/8-in. plate, 6-in. T's cut from 12-in. Junior Beams (11.6 lb per ft), 2-in. pipe flanges and plugs, forged wedge guides and 1-1/2 in. nuts. The 3/16-in. and 3/8-in. plates are available from most mills in all parts of the country. The raised pattern plate, however, is available only in the midwestern and eastern parts of the United States. The 6-in. T's were found to be proprietary items available at one steel mill only, located in the eastern United States. The other items are obtainable in all sections of the country. This study of availability of material made apparent two factors that conflicted with the original concept of the pontoon, namely: (1) two items of steel were available in only one section of the country; (2) shipping of these items to other sections of the country was not only costly but used valuable railroad car space, always short in wartime. In addition, the 6-in. T was expensive due to the shape extra. The assembly angles of the sizes used (6- x 6- x 3/8-in., 6- x 6- x 1/2-in., and 8- x 8- x 1/2-in.) are available in all sections of the country.

Manufacturing Methods and Techniques

Laboratory representatives visited three manufacturers of pontoons to study their methods and techniques. In addition, three fabricators who made pontoons during World War II were contacted and their manufacturing procedures discussed. The information

gained from these visits was instrumental in the Laboratory developing a P-10 component[14] for overseas assembly of T6B and T7A pontoons.

Fabrication Problems

The discussions with six fabricators gave an insight into the problems encountered in the manufacture of pontoons. The consensus of opinion was that the cut-off corners of the pontoons, fitting of interior framing, positioning and welding of the corner straps, and the large amount of inside welding were the trouble spots in fabrication. The cut-off corners necessitated accurate shearing of the four corners of all plates as well as all four edges, and the closure plates were difficult to form and to fit into the triangular opening. The interior framing had to be cut accurately to length, and the Junior Beam had to be split exactly in half in order to obtain a proper fit at the edges of the pontoon (see Figure 11).

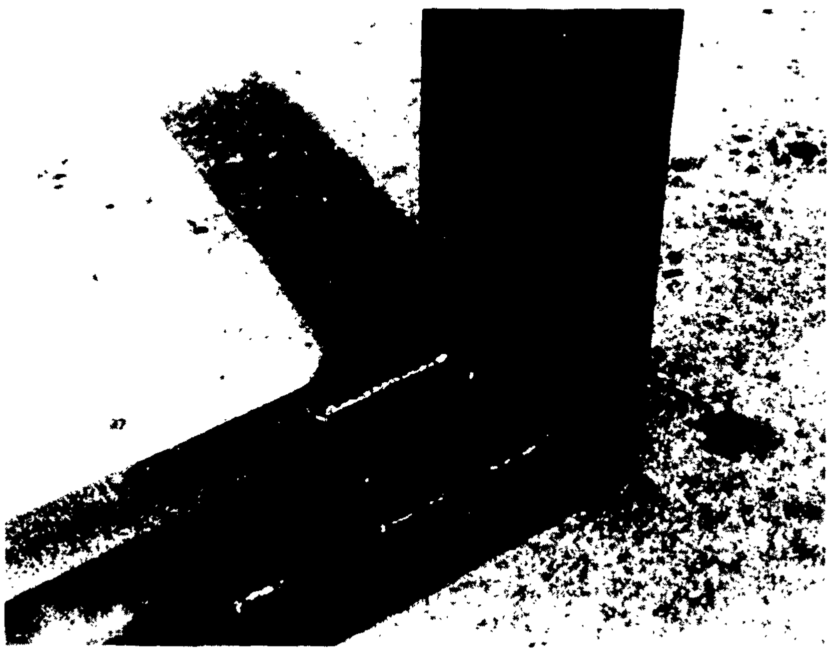

Figure 11. View of interior framing of T6B pontoon.

The location of the corner straps was a major problem. First, the corner strap had to be exactly square, and second, the jig for placing all eight at once had to be checked continually for accuracy to insure proper assembly of the pontoons into strings. The last problem was the amount of inside welding that had to be done. This was especially bad in warm climates where the welder, in his leathers, had to weld for approximately one and one-half hours to complete the inside of one pontoon. The overseas pontoon reports[15, 16] reveal that the same type of difficulties were experienced by the construction battalions in the fabrication of pontoons.

The main problem confronting the angle fabricators was the punching of the rectangular link and pin holes. Two reasons were set forth for this difficulty: (1) a rectangular punch is difficult to maintain; (2) the rectangular holes had to be made in the fillet of the angle.

Other problems included punching of the holes for plug-welding the wedge bars, and keeping the angle straight and true (punching and welding distort the angle considerably). During these talks with angle manufacturers, the high cost factor of the breech plug splice came to light, which later played a major role in developing the concept of the new angle design.

DEVELOPMENT OF NEW DESIGN

The background of the initial studies and the experiences of pontoon fabricators formed an excellent basis for a new design that would eliminate as many of the past difficulties as possible.

P-1 Pontoon

From the initial study, the size of pontoon and the shell-plate thickness appeared to be ideal for the use and wartime life of pontoon structures. However, with elimination of the jewelry the cut-off corners on the pontoon no longer appeared a necessity, and this opened the way to new ideas for attachments to the angle. Study of the fixed nut brought to light several of its disadvantages, namely: (1) the fixed nut did not allow for any tolerance when assembling the pontoon to the angle; (2) the threads in the nut were susceptible to

rusting in storage and shipment. If the threads rusted or were stripped in assembly (a common occurrence because of alignment difficulties), replacement was difficult and costly.

After considerable study, it was decided that a small watertight, open-end box in each corner, into which a loose, flanged nut could be placed at time of assembly, would be the most advantageous solution to the problem (see Figure 12). The flanged nut shown in Figure 13 was designed to be forged from SAE 1040 steel. The position of the nut on the present pontoon is governed by the position of the jewelry. With elimination of the jewelry, the position of the nut in the new pontoon could be moved closer to the corner of the pontoon, making the nut more accessible in the corner box and reducing the distance between bolt holes in adjacent pontoons, thereby reducing bending in the assembly angles. Elimination of the corner strap previously made it possible to make the downstanding leg of the assembly angle flush against the pontoon, thereby affording protection to this leg of the angle.

Considerable study of the framing was made in order to have members which were not proprietary items and which could be easily joined at the corner of the pontoon. First, a review was made of all commercially rolled shapes in an attempt to find a standard shape that had the same section modulus and weight as the Junior Beam. It was found that all of these standard shapes were heavier than the Junior Beam. Next, structural shapes formed from plate were investigated. For uniformity of material, 3/16-in. thick plate, the same as the pontoon shell, was chosen for investigation. Calculations showed that a 5-1/2 by 3- by 3/16-in. formed angle had very nearly the same section modulus and weight as the Junior Beam. This angle section also made possible elimination of the difficult fitting problem in the pontoon corner. The interior framing members were all made the same length (4 ft 0 in.), leaving a clearance at each end, structural continuity around the corner being accomplished with a gusset made of 3/16-in. plate (see Figures 14 and 15). Launching tests on the P1X pontoon revealed that by flanging these gusset plates, considerable additional strength could be obtained (see Figures 16 and 17).

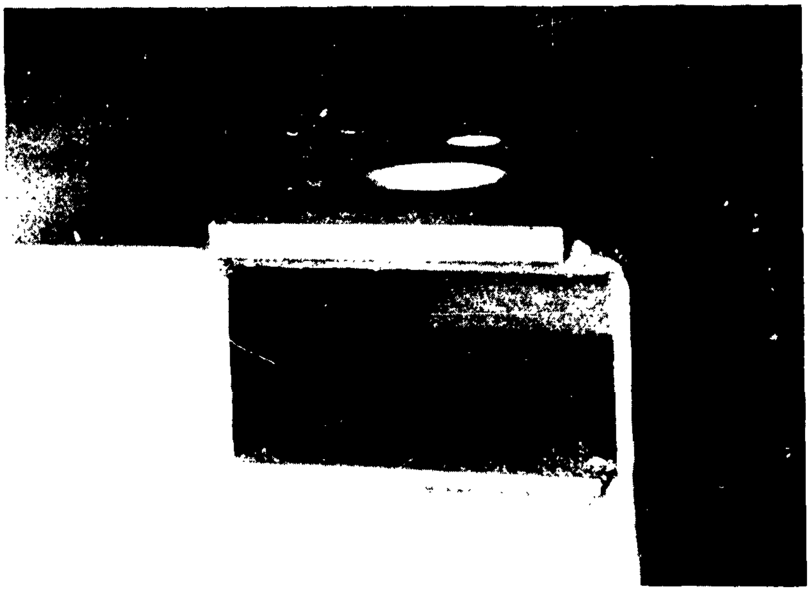

Figure 12. Preliminary design of corner box of P-1 pontoon.

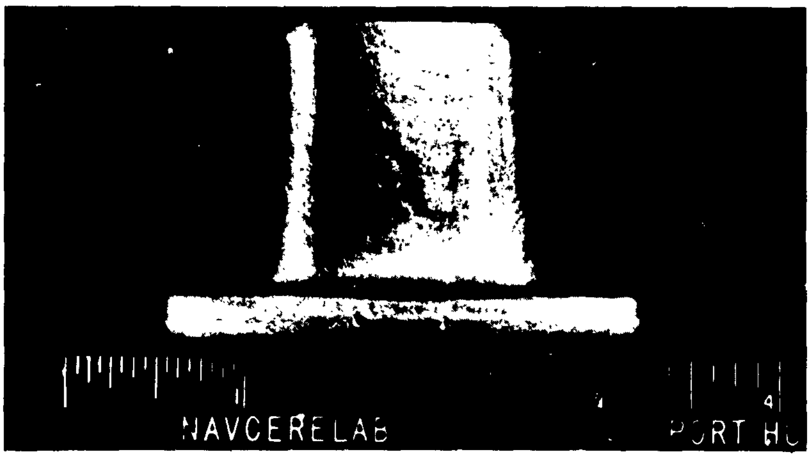

Figure 13. Preliminary design of loose flanged nut.

Figure 14. Preliminary design of interior angle framing of P-1 pontoon formed from 3/16-in. plate.

Figure 15. Preliminary design of angle framing of P-1 pontoon, showing 3/16-in. plate gusset at corner.

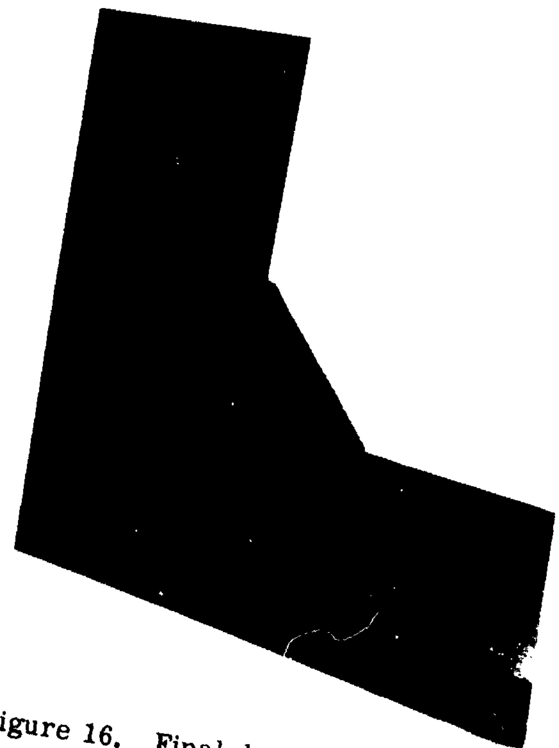

Figure 16. Final design of interior framing, showing flanged gusset formed from 3/16-in. plate.

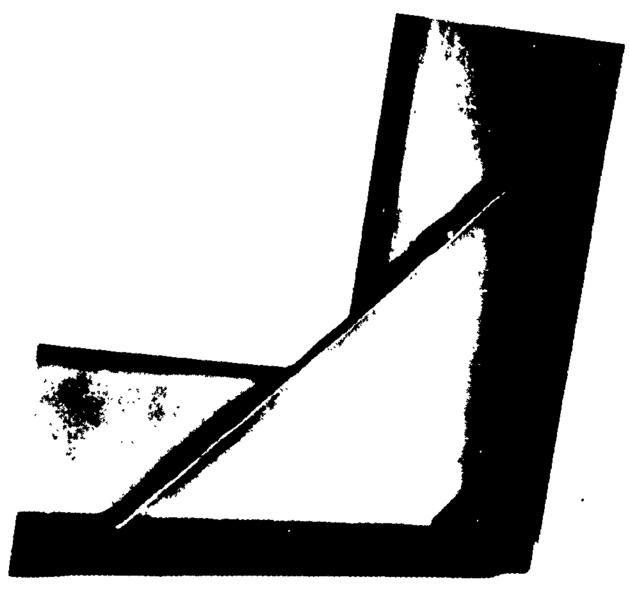

Figure 17. Final design of interior framing showing flanged gusset.

The raised pattern deck plate was studied for traction and availability. It was found that not all steel mills in the United States rolled raised pattern plate; the main source was the midwest and east. The plate weighs 8.7 lb/sq ft compared to 7.65 lb/sq ft for the plain plate. A traction comparison was made between plain black steel plate and raised pattern plate, both wet and dry. Results showed that a jeep had slightly better traction on raised pattern plate when the surfaces were dry, but when they were wet traction on the two types of plates was the same. A non-skid paint was placed on the plain plate and the test was repeated. As can be seen in the accompanying table, the jeep had better traction on the painted plate when the surfaces were dry, but when the surfaces were wet the painted plate traction was double that of the raised pattern plate.

Plate (type)	Dry (lb)	Wet (lb)
Plain	1500	900
Raised pattern	1800	900
Non-skid paint	2000	1800

The plain plate plus the paint results in the same cost as the raised pattern plate without considering the cost of shipment to manufacturer of the raised pattern plate.

With the above investigation and conclusions as a basis, the new P-1 pontoon was designed as shown on Y&D Drawings 652,338 and 652,339 (see Appendix III) and in Figures 18 and 19. Figure 20 shows both the T6B and P-1 pontoons.

P-2 Pontoon

The initial study revealed that the curved bow of the T7A was designed from data on efficient hull shapes, but since efficient hull shapes are mainly effective in high-speed vessels, they were not considered a necessity for slow-moving barges. Based on this reasoning and the fact that most commercial barges have a straight-line sloping bow, the shape of the P-2 was set with a straight-line sloping bow, as in Figure 21. The sloping bow suggested the idea of inverting the P-2, as in Figure 22, and using it as a ramp to replace the T8 and T11 pontoons. Considering both uses for the

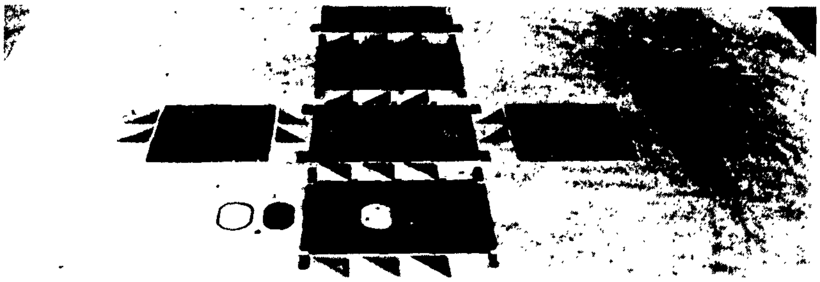

Figure 18. View of P-1 pontoon parts in display.

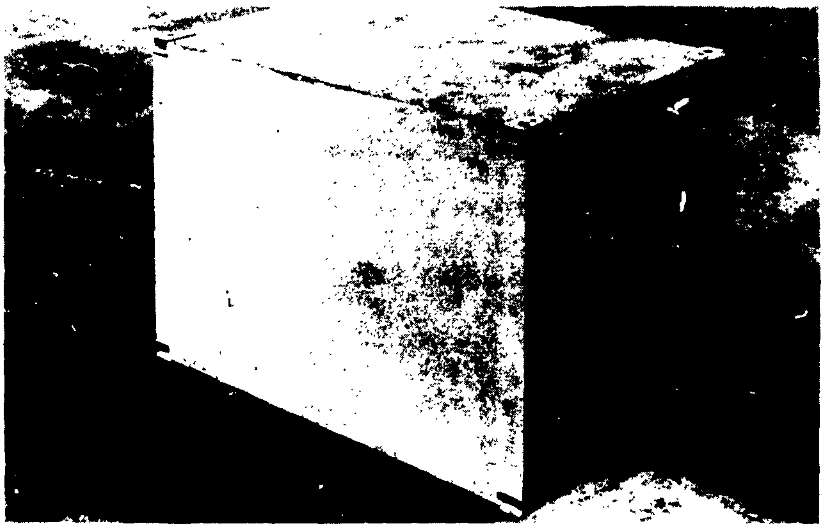

Figure 19. View of P-1 pontoon assembled.

Figure 20. View of T6B and P-1 pontoons.

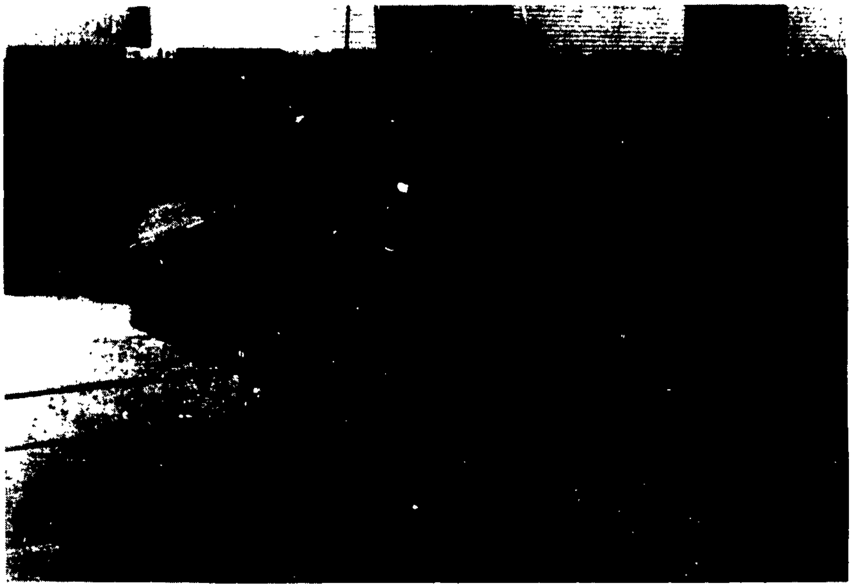

Figure 21. P-2 pontoon viewed in position to be used as a bow or stern.

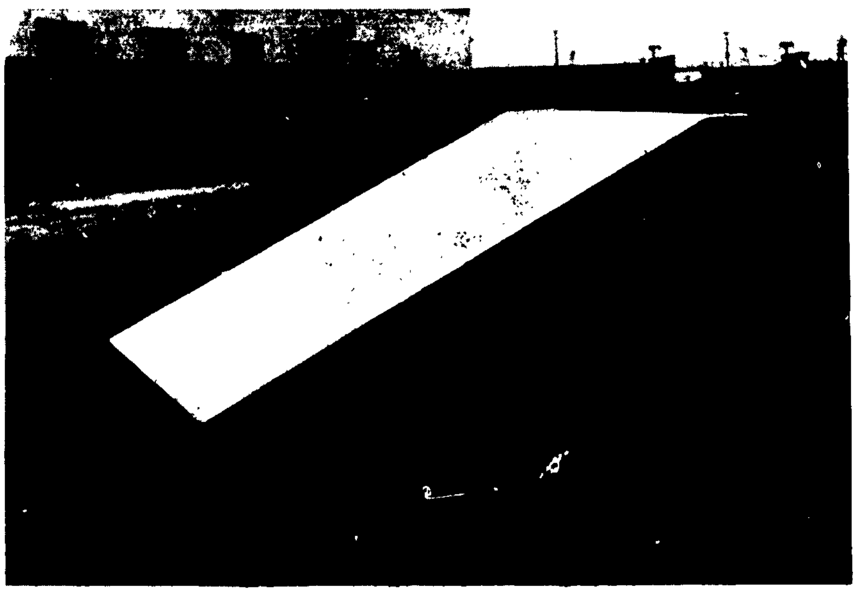

Figure 22. P-2 pontoon in position to be used as a ramp pontoon.

pontoon and realizing that more bow and stern pontoons (T7A) were used than ramp pontoons (T8 and T11), the length of the P-2 pontoon was set at 8 ft, which is 1 ft longer than the T7A and 2 ft 9 in. shorter than the combined T8 and T11. The corner box and interior framing details (see Figures 23 and 24) were made the same as in the P-1 pontoon, but three diagonal angle braces, one at each framing member, running from approximately the center of the sloping bottom to the center of the deck, were added for increased strength. The hole spacing on the P-2 pontoon was set the same as on the P-1 in order to simplify the angle system. The resulting P-2 pontoon was more easily fabricated, only slightly heavier than the T7A, slightly less in cost than the T7A, and less than half the cost of the combined T8 and T11. The resulting design is shown on Y&D Drawings 652,340 to 652,343 inclusive (see Appendix III).

Angle Design

The study of the present design revealed two major items that a new design should not have: (1) a large number of different angles and possibility of new types as requirements change, and (2) a costly, absolute type of splice. Based on these two items, a new concept was developed called a series system. By making the splice in the center of the pontoon rather than between pontoons, the splice was in a protected area rather than in an area of maximum stress, and by making the hole spacing on the P-1 and P-2 the same, the angle system developed into 7 basic types, together with 2 end-condition types which have right- and left-hand designs, making a total of 11 types (see Figure 25). With these 11 types, it is possible to make any length string of pontoons from 3 to infinity.

For assistance in assembly of the pontoons in the angles and to protect the bolt from shear in event the pontoon shifted longitudinally in the angles, a 3/8-in. plate 4 in. wide and 8-1/2 in. long was welded to the angle between pontoons. This plate was placed so as to have 1/8-in. clearance on each end with the reinforcing plate on the corner of the pontoon (see Figure 26).

The resulting angle system design is shown on Y&D Drawing 652,344 (see Appendix III).

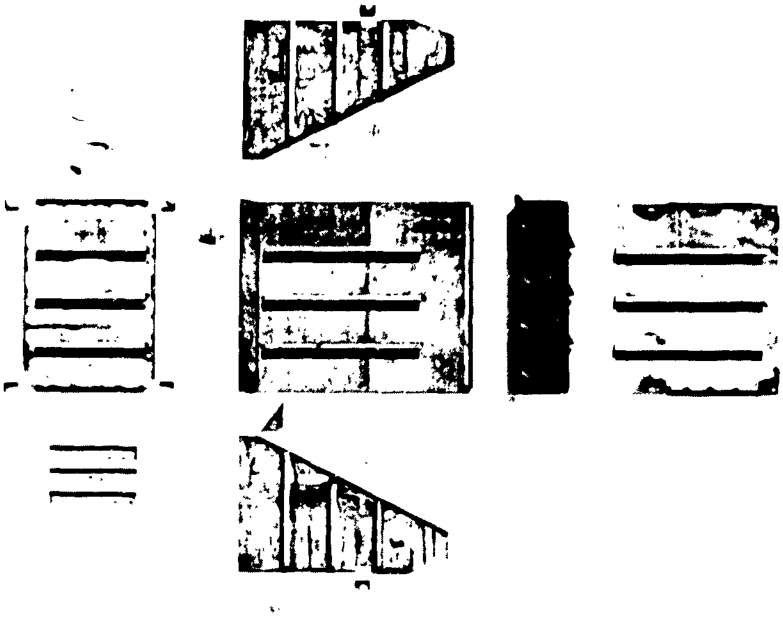

Figure 23. View of P-2 pontoon parts in display.

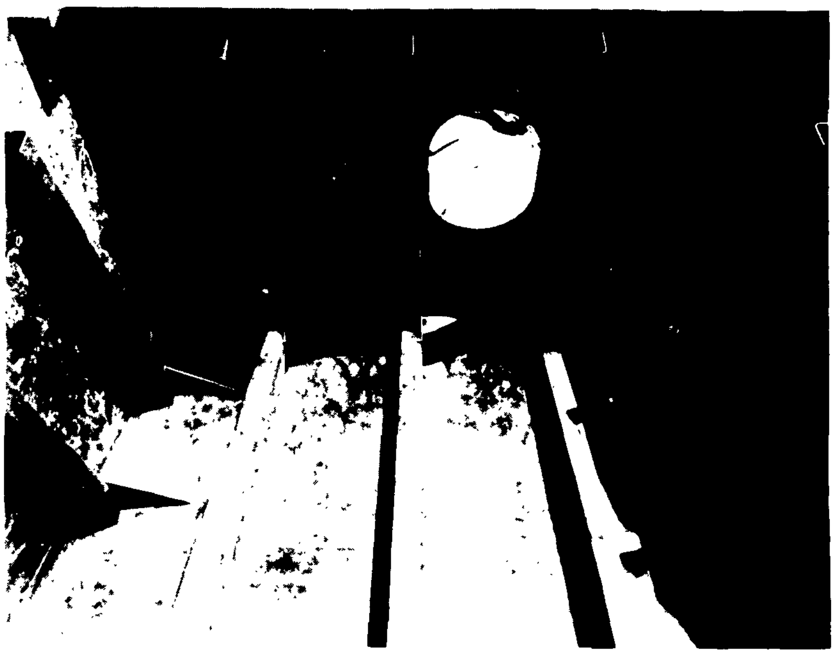

Figure 24. Interior framing of P-2 pontoon, showing angles and gussets.

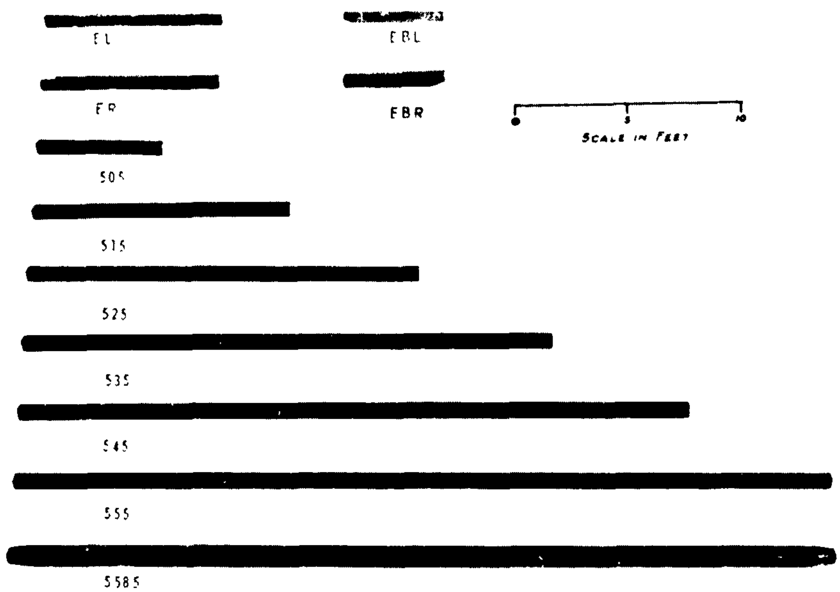

Figure 25. View of new design pontoon angle series in display.

Figure 26. Steel plate, 3/8 in. thick, welded to inside leg of new pontoon angle.

Flanged Nut

The design of the flanged nut was governed by two factors: (1) the area on the top must be sufficient for bearing; (2) the box containing the nut must be of sufficient size to insure ease in fabrication of the pontoon. The first design (see Figure 13) was used because the forging dies were available at a local forging company and the die cost could be saved by using this design for the prototype assemblies. This design, however, presented a problem in the manufacture of the pontoon, as a weld inside of the nut box interfered with the flange on the nut. This meant that the weld on the inside of the pontoon had to be watertight the first time or the pontoon would have to be opened up after test to repair any leaks. To eliminate this problem, the nut design was changed (see Figures 27 and 28), and the flange was moved down far enough to permit welding on the inside of the nut box.

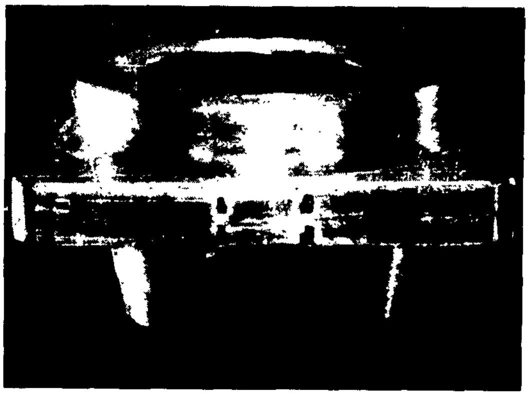

Figure 27. View of redesigned loose flanged nut.

Interchangeability Study

Having corrected the major portion of the deficiencies in the fabrication and assembly of the present pontoon system by means of the new design, an investigation was made to determine the interchangeability of the new design with the present system. To carry out this investigation, there was constructed and tested a pontoon (P1X) using the design features of the P-1 but with the hole spacing (resulting in a deeper and longer corner box) the same as the T6B pontoon.[17] In addition, drawings were made of an angle system using the present type of angle. This system resulted in 15 types of angles. This angle system has been used on three different barges and four different causeway sections, which have been in service at the Laboratory for more than a year. No angle or joint damage has resulted on any of these assemblies (References 9 and 10 contain information on several of these assemblies).

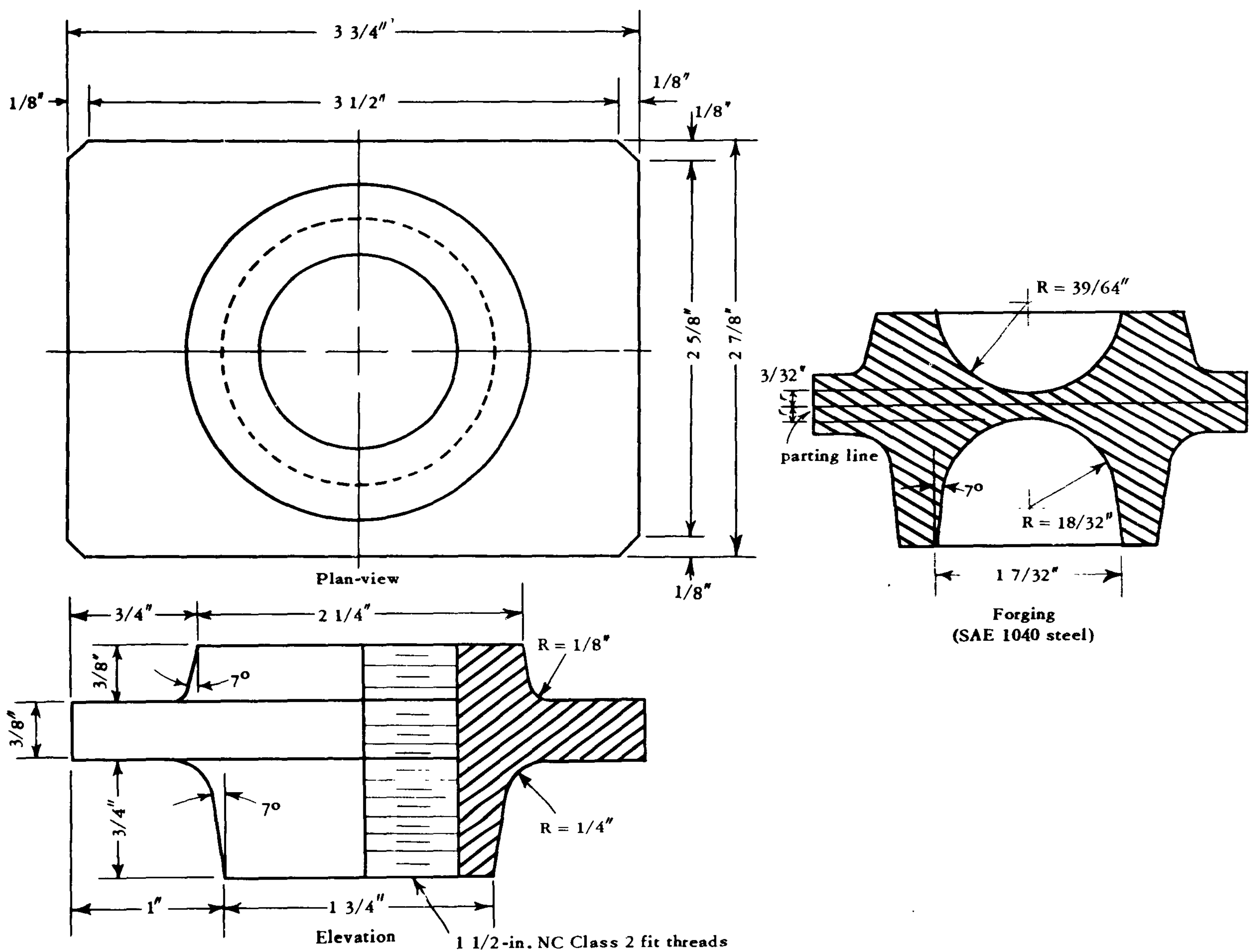

Figure 28. Drawing of redesigned loose flanged nut.

In carrying the investigation further, it was realized that, in any analysis of this type, all the major parts of the pontoon assembly (standard pontoon T6B or P-1, the bow and stern pontoon T7A or P-2, the ramp pontoons T8 and T11 or P-2, and the angle systems) had to be considered at the same time or the study would be meaningless. Elimination of the jewelry, link and pin, and breech plug splice affected the angle design to the greatest extent, and therefore it was decided to start the study with the angles, keeping in mind the other elements also. Three items made interchangeability of the two angle systems difficult: (1) the splices for the two systems did not occur at the same location; (2) the wedge bar was not necessary for the new system and blocked the pontoon corner box opening for inserting the flanged nut (see Figure 29); and (3) the link and pin holes were neither required nor used in the new system.

Figure 29. View of standard angle and P1X pontoon corner.

Further study revealed that the first objection could be overcome by cutting off each end of the present angles to fit the new series type. The elimination of the wedge bar on the present angles in stock was considered impractical, as the angles would become badly warped when the wedge bars were flame cut. The third item could be solved by not using the link and pin when the two angle types were used together.

In considering the standard pontoons of each design (P-1 and T6B) for interchangeability, it was found that, although the new design could be made interchangeable (P1X) with only a slight increase in

cost (deeper and longer corner box), the assembly time was increased, and it was found that it was not possible to insert the flanged nut when the present type of angle was used, as the wedge bar on the angle blocked the entrance to the corner box.

The attempt to make the P-2 and T7A interchangeable ran into major difficulties. Namely, the present angles would not fit the P-2 nor vice versa, the P-2 being a foot longer than the T7A. The same conclusions were reached in the study of the P-2 versus the T8 and T11.

The final conclusion of the study was that interchangeability of the two systems would not be feasible but would result in a cumbersome, inefficient system which would necessitate many special adaptions and a larger number of items in the stock catalog than at present.

Realizing that interchangeability was a desirable but not a necessary feature, it was considered that the study should be expanded to cover an analysis of the available stocks and field use to determine the effect of the introduction of a non-interchangeable design into the system.

The pontoon catalog was studied and a list of accessories affected by the bolt-hole spacing was prepared (see Appendix II). This accessory list, combined with a list of the four types of pontoons and 27 types of angles, was used to study pontoon stocks and methods of field ordering and use. It was found that the field forces ordered assemblies (3 x 12 barge, 2 x 30 causeway, etc.). Further, it was found that rarely, if ever, did the field forces disassemble a barge or causeway and replace damaged pontoons or angles. Instead, the damage was repaired by patching, or, if damage was extensive, the entire unit was surveyed.

More important, it was found that in actual combat pontoon structures were new for each operation and were seldom recovered. This was considered a very significant fact in analyzing the necessity for interchangeability. The above facts formed a basis for stocking, ordering and issue. From the analysis of present stocks, it was found that the major portion (pontoons and angles) of the pontoon gear could be used up in these standard assemblies. Further, it was found that if the pontoons and angles were reduced to a minimum

by regular orders, no excesses of accessory items would result (see Appendix II). Another major fact that was brought to light was the small amount of old-design material on hand in comparison with World War II usage.

The final conclusions of this investigation were that interchangeability was not a necessity, that it would be possible to introduce a new non-interchangeable pontoon system while present stocks were being reduced to a minimum by regular issue, and that potential savings of considerable magnitude were possible through the adoption of the new design.

Accessories for New Design

In order to evaluate the new design, certain accessories were designed. These included: (1) an AP-1 plate to serve the same function as the present P-5 plate, (2) a tapered bracket for use under the propulsion-unit foundation on the sloping part of the P-2 pontoon (see Figure 30), (3) a new lightweight ramp for use with either a 3 x 12 ramp barge or a causeway ramp, and (4) a lightweight deck closure (see Figures 31 and 32). In each of these designs, an attempt was made to reduce weight and cost and to improve the operation.

Figure 30. Standard unit foundation with tapered plate to fit P-2 pontoon.

Figure 31. New pontoon deck closure placed beside opening.

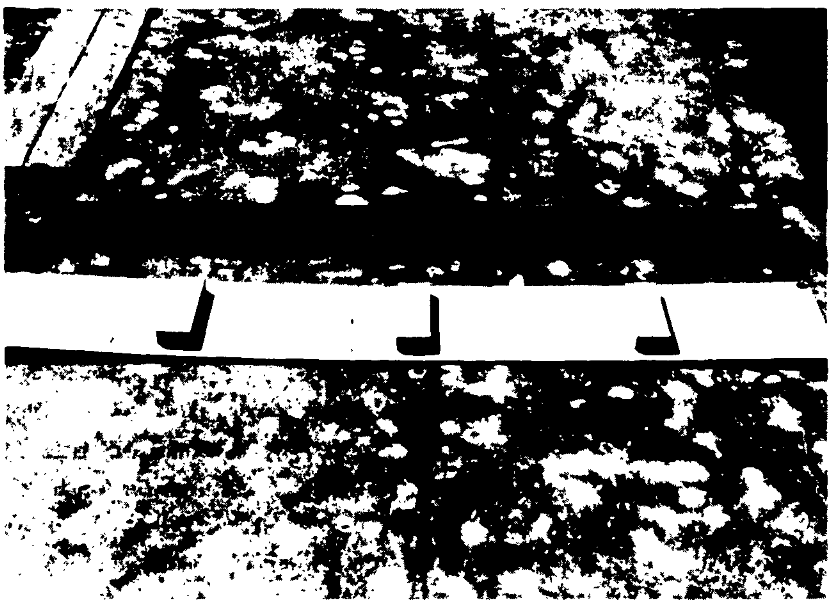

Figure 32. New pontoon deck closure showing back side with channel stiffeners.

EVALUATION OF NEW DESIGN

The new design had been developed to a point where further improvement could only be accomplished by the testing of a prototype assembly. For this prototype, it was decided that thirty P-1 pontoons, six P-2 pontoons, approximately 1000 ft of angle, sufficient flanged nuts, and AP-1 plates would fully evaluate the new design. With this amount of material, it would be possible to statically test a 1 x 24 string for comparison purposes,[9, 10] a 3 x 7 barge for propulsion-unit tests, and a 3 x 12 ramp barge for beaching and launching tests.

Fabrication

Since pontoon assembly jigs for the overseas pontoon assembly depot (P-10 component) had been designed, plans were made to have them fabricated and evaluated. It was decided to let a contract for the jigs, three T6B pontoons (for evaluating the jigs), and the thirty P-1 pontoons to the same contractor so the jig design could be evaluated by fabrication of the jigs from the drawings and the jigs could be tested for assembly of the T6B pontoons and could be used to assemble the thirty P-1 pontoons. The thirty P-1 pontoons were fabricated with ease in the P-10 component jigs with only slight modification to the jigs, the corner strap jigs, of course, not being necessary. The P-1 pontoon passed the pressure test of 20 psi internal water pressure. Non-skid paint was used on the decks of the pontoons. Because of the small number of P-2 pontoons to be built, it was decided to build them in the Laboratory shops. Subassemblies were made on work tables, and a simple assembly jig was used for final assembly. The pontoons were assembled with no undue difficulty, as in Figure 33. Non-skid paint was used on the decks of these pontoons also.

Since the angles presented no special fabrication problem and adequate drawings were available, bids were obtained from three steel fabrication companies and a contract was let to the low bidder. The desired angles were fabricated with standard steel fabrication equipment without special tooling. The gages shown on Y&D Drawing 652,344 (see Appendix III) were used in the inspection of the angles before delivery.

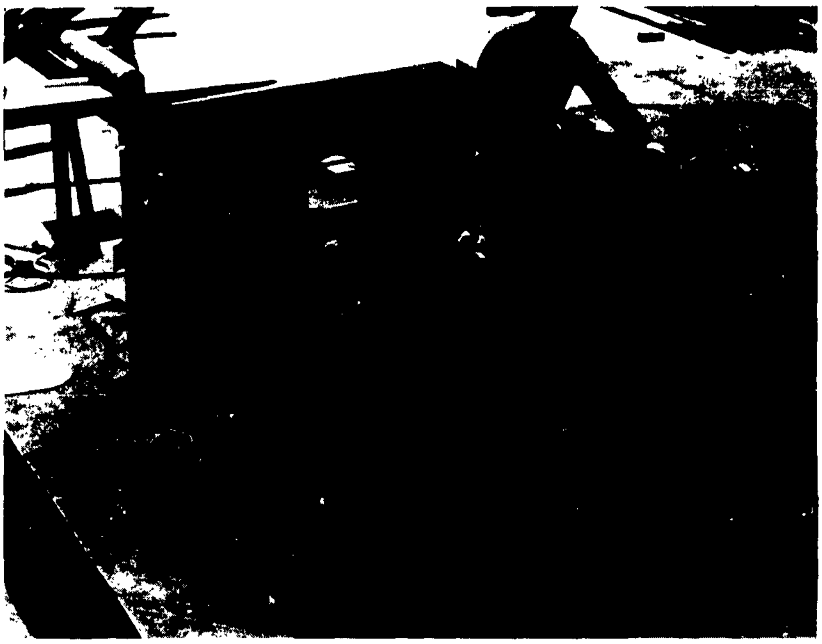

Figure 33. View of assembly of P-2 pontoon.

The miscellaneous items such as deck closures, AP-1 assembly plates, propulsion-unit foundations, and landing ramps were fabricated in the Laboratory shops. The flanged nuts were procured from a forging shop that had on hand a die that made a satisfactory nut for the purpose. The fabrication of this nut presented no manufacturing problem.

Assembly

Since one of the main factors of the new design was the ease of assembly, this feature was carefully observed during the assembly of a 1 x 24 string, a 3 x 7 barge, and a 3 x 12 ramp landing barge. In all cases, the angles were laid out and welded together easily (see Figure 34), and the hole spacing across the welded splices was easily maintained. The pontoons were easily placed in the angles, using cable slings with hooks that fitted into the bolt holes in the corners of the pontoons (see Figure 35). The 3/8-in. plate on the

Figure 34. Clamp used to position new angles while welding.

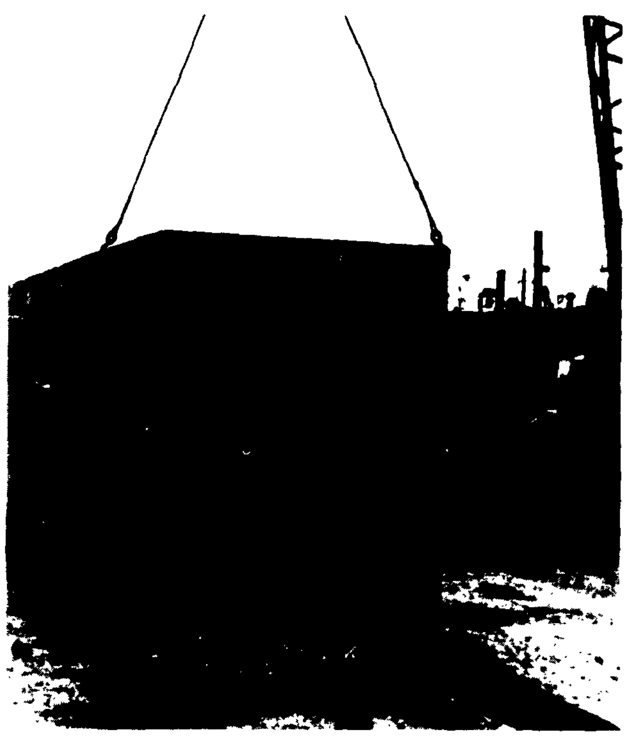

Figure 35. Assembling P-1 pontoons in new angles.

angle helped considerably in placing the pontoon so that the 1-5/8 in. hole in the angle and the 1-5/8 in. hole in the corner of the pontoon were in alignment. The loose, flanged nut was easily placed, and the 1-1/2 in. dia. A6 bolt could be started by hand, with the final tightening being accomplished by an air wrench. The pontoon strings were attached to each other with the AP-1 plates, top and bottom, with no difficulty being encountered due to the loose nut.

In all the assembly work, the loose, flanged nut greatly facilitated the starting of the bolts because the loose nut could be tipped to align its threads with those of the A6 bolt, which cannot be done with the present design.

Considerable time was saved in assembly of all components because of ease of assembly and omission of the jewelry. It was estimated that this saving amounted to approximately 25% per pontoon.

Static Load Tests

The early Laboratory tests for effectiveness of the pontoon jewelry[9, 10] were made on a 1 x 24 pontoon string supported on a 100-ft span. Consequently, for comparison of the new design with the present design, a similar test was made on a 1 x 24 string of new pontoons and angles (see Figure 36). The recorded stresses and deflections are shown in Figures 37 and 38.

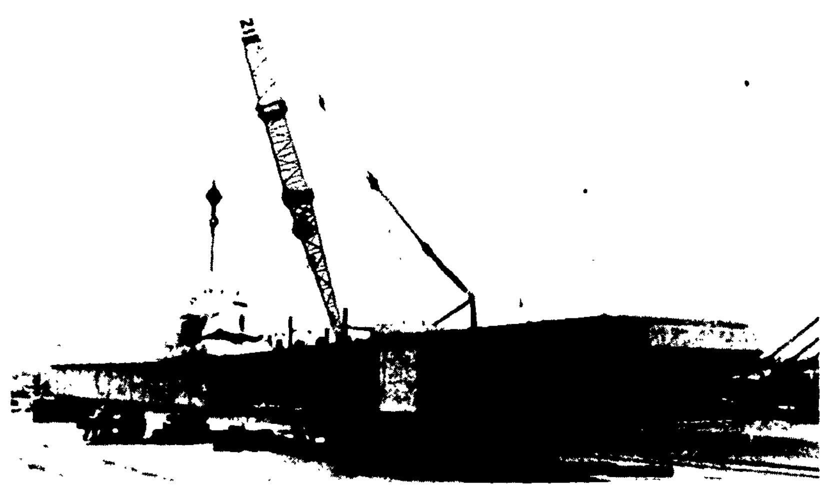

Figure 36. Static load tests of new pontoons and angles.

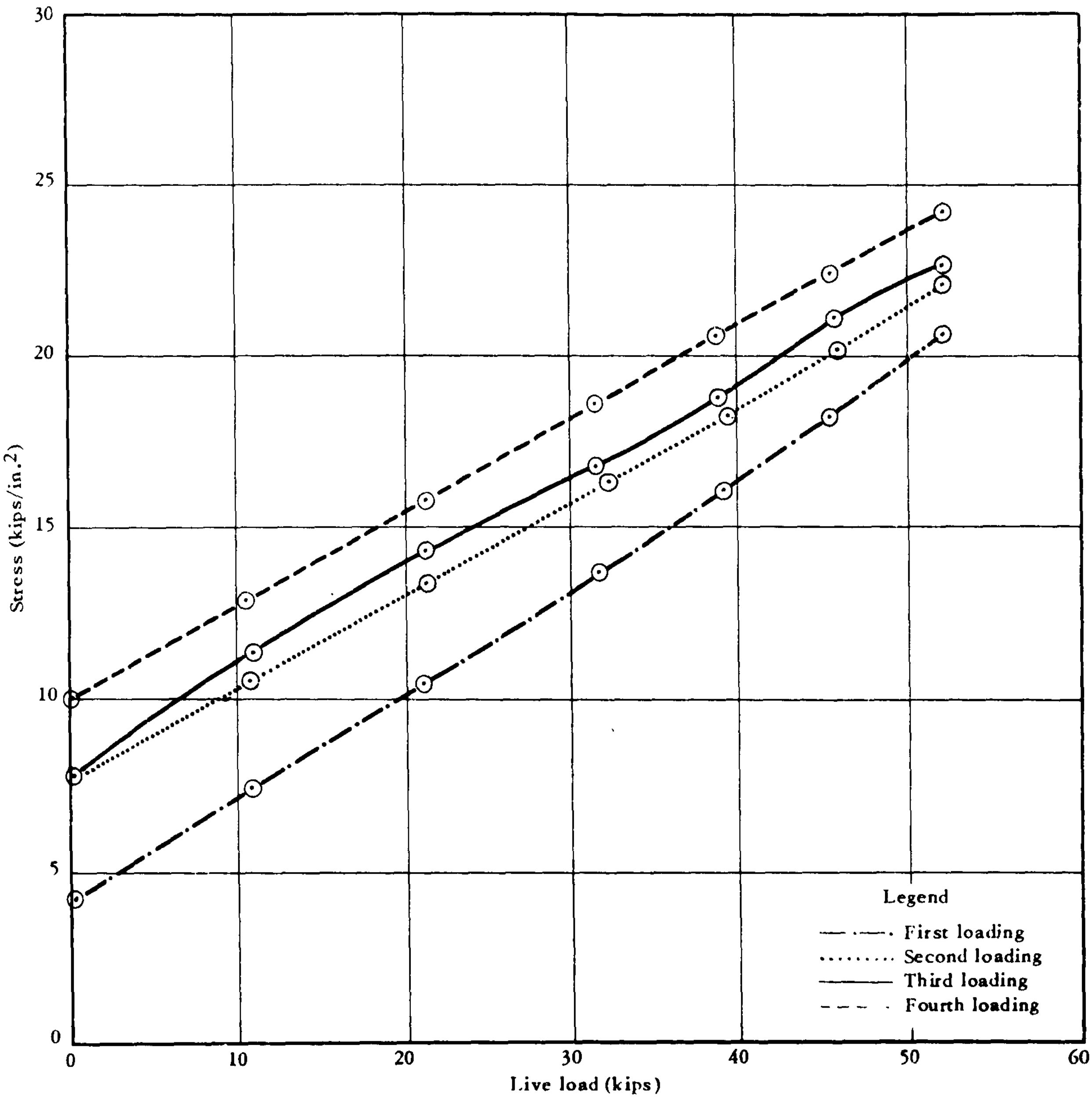

Figure 37. Tension stresses on 8-in. angle at center of 1 x 24 string of new pontoon design on 100-ft span.

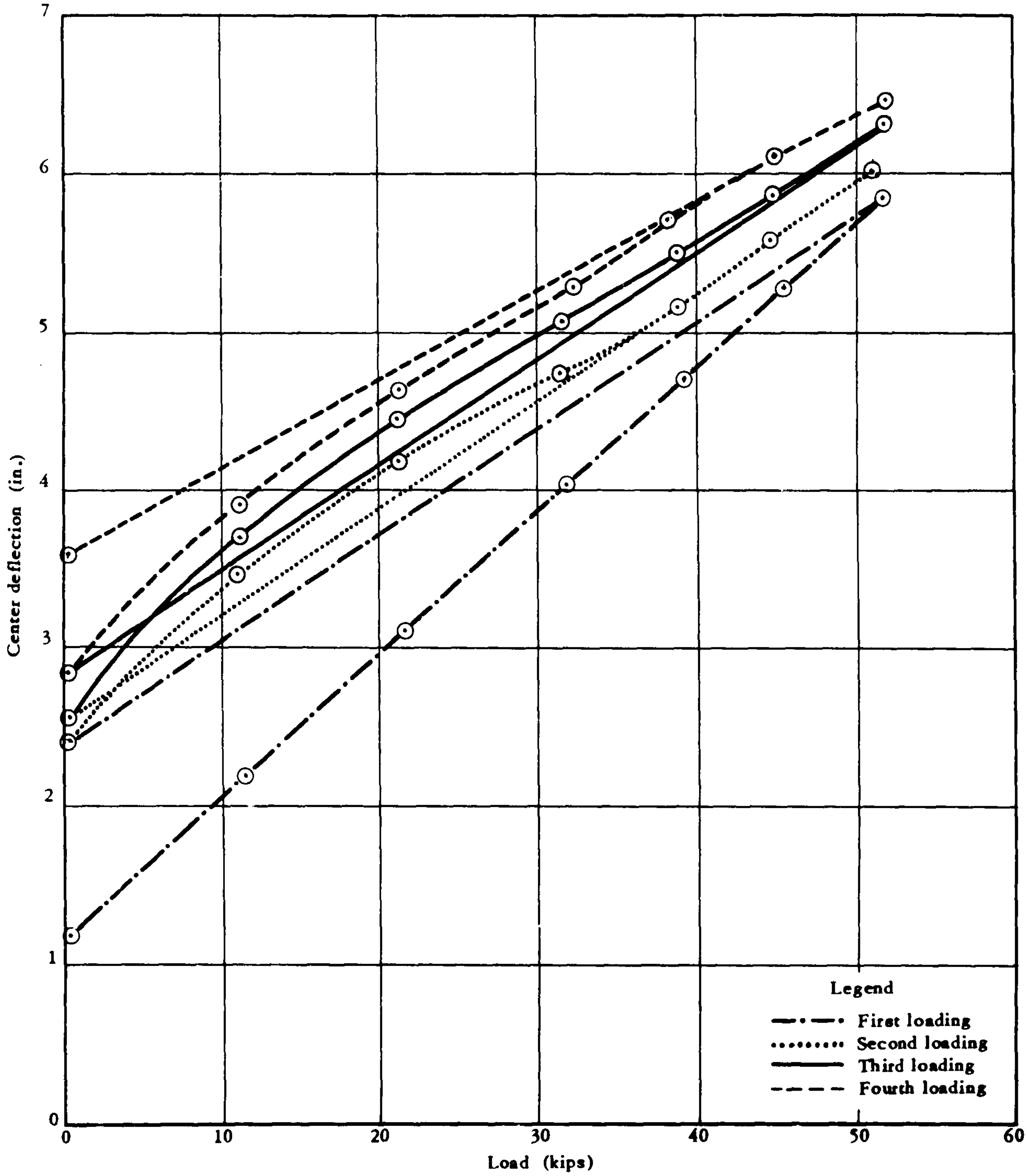

Figure 38. Center deflection vs load, 1 x 24 string of new pontoon design on 100-ft span.

The 1 x 24 string of the new design was made of a combination of 6- and 8-in. angles, while the string of the present design was assembled with all 8-in. angles. The stresses in the angles of the new design were approximately 30% less and the deflection was approximately 20% less than those of the present design. The decreases in stresses and deflection were attributed to elimination of the link and pin holes and placing of the A6 bolts closer together in adjacent pontoons.

Propulsion Tests of 3 x 7 Barge

In order to evaluate the effectiveness of the P-2 pontoon when used as a bow and stern pontoon, propulsion-unit tests were conducted on two 3 x 7 barges, one of the present design using T7A and T6B pontoons and the other using P-1 and P-2 pontoons.

Bollard and speed tests were conducted with the two barges using 02D propulsion units (see Figures 39, 40, 41, and 42). The bollard tests were made with the propeller in forward position, then rotated 180 degrees, and then in reverse position using the clutch, with various loads on the barges to determine the effects of deeper drafts. The barges were tied to the dock, and a dynamometer was used to record the pull on the lines. The results of these tests are shown in Figures 43 and 44.

Speed runs were conducted on both barges at the same time in two directions over an Admiralty nautical mile of 6080 feet. The results of these tests showed that the sloping surface on the P-2 pontoon had no detrimental effect on the speed of the barge. The results of the tests are shown in Figure 45.

Tests of 3 x 12 Ramp Barge

In order to evaluate the P-2 pontoon for use as a ramp and the 3 x 12 barge for LST side-launchings, a 3 x 12 ramp barge was assembled. A new type of hinged ramp (see Figure 46), fabricated from steel WF beams and plate, was used from the front end of the P-2 pontoon to the beach. This ramp weighed 400 lb or approximately two-thirds of the weight of the present type of wooden ramp.

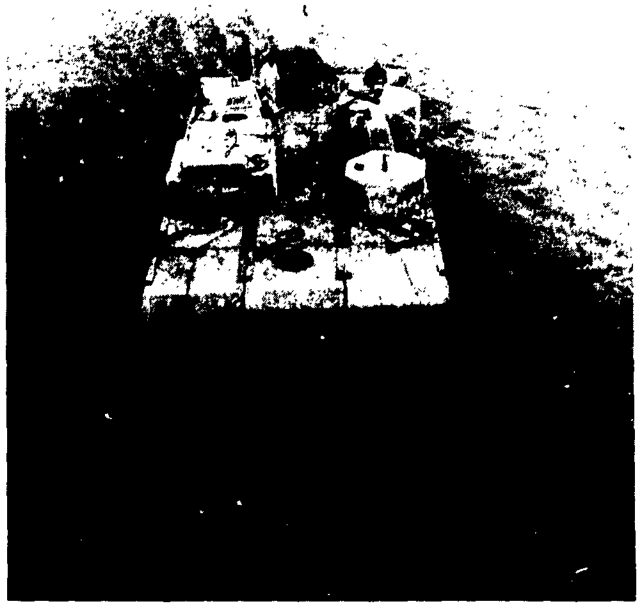

Figure 39. One 3 x 7 barge, new pontoons, during bollard tests. Barge in reverse position.

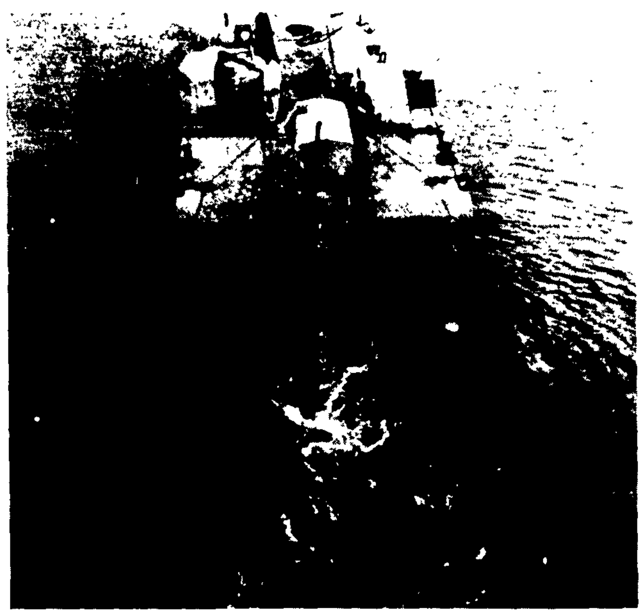

Figure 40. Bollard tests with new pontoons. Barge in forward position.

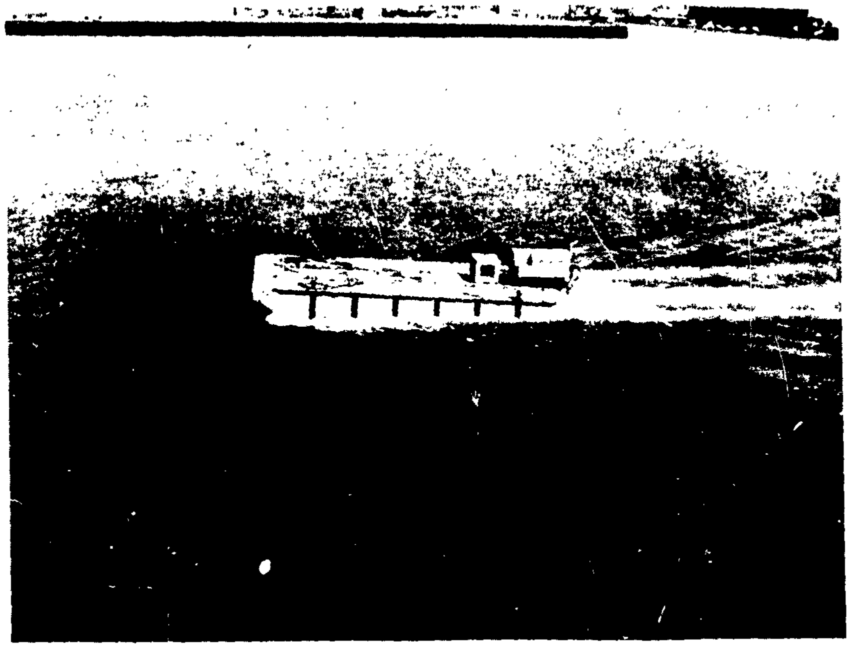

Figure 41. One 3 x 7 barge, assembled with new design pontoons and angles, during test.

Figure 42. One 3 x 7 barge, new pontoons and angles, with 50-ton load during tests.

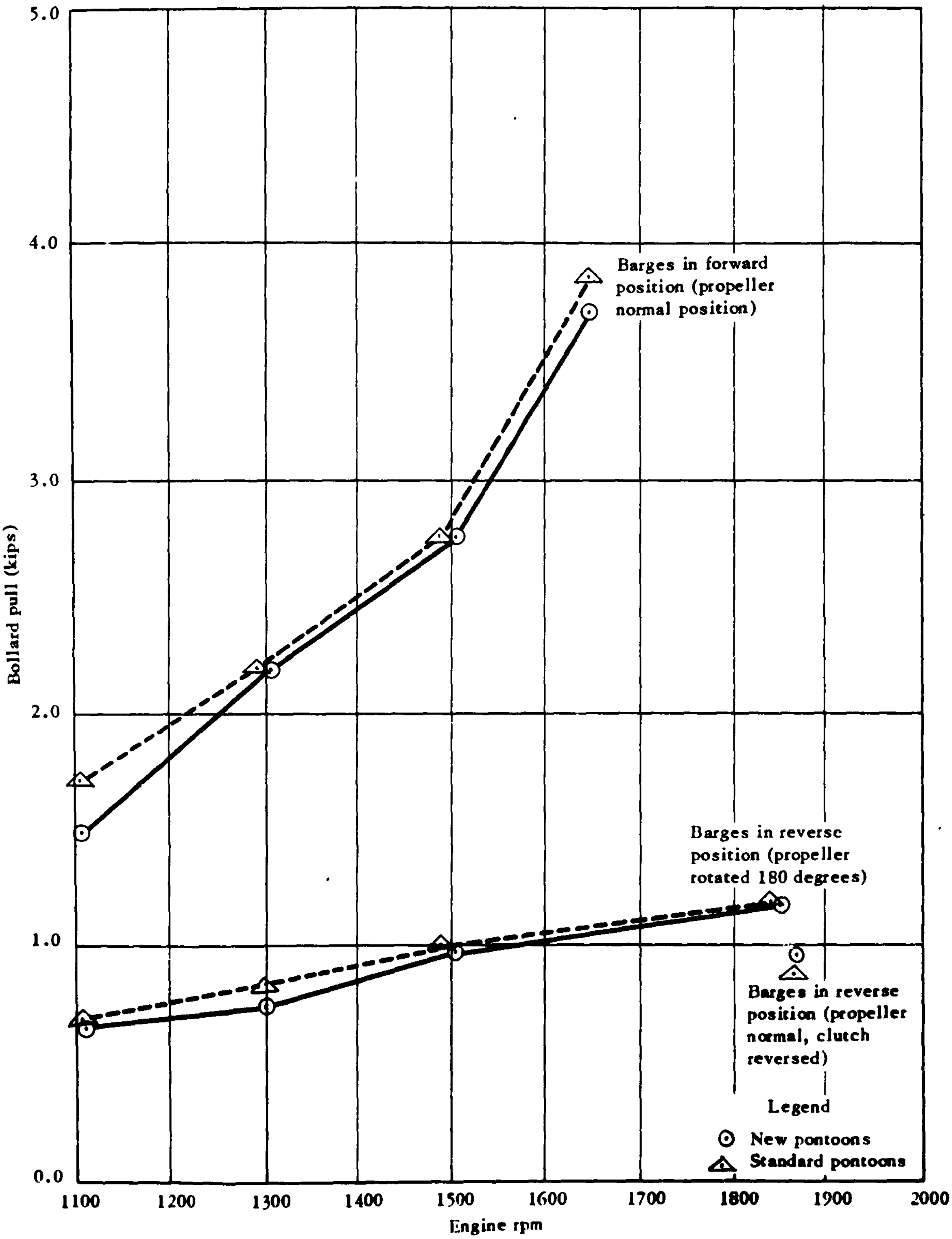

Figure 43. Bollard pull vs rpm with no load on barge.

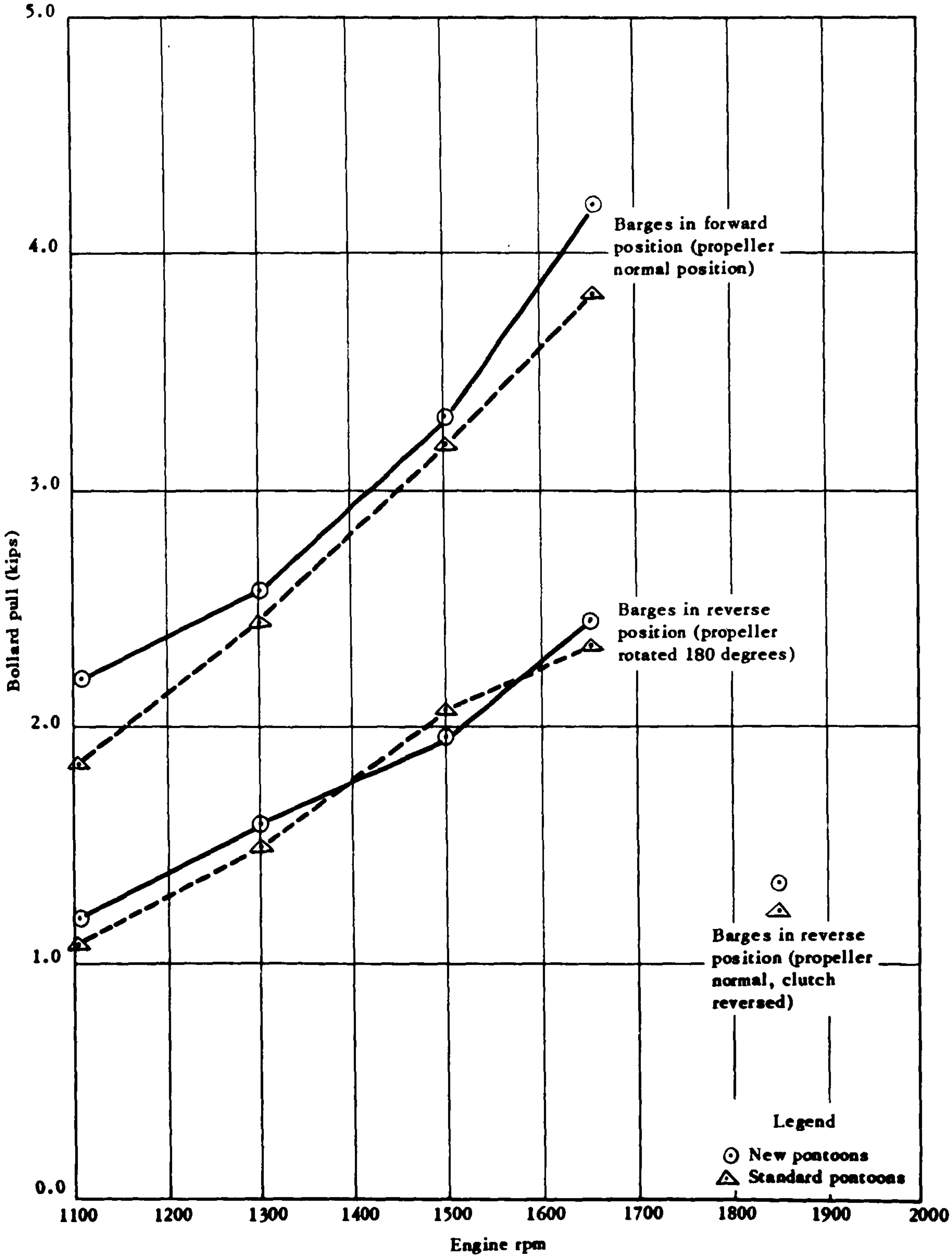

Figure 44. Bollard pull vs rpm with 30-ton load on barge.

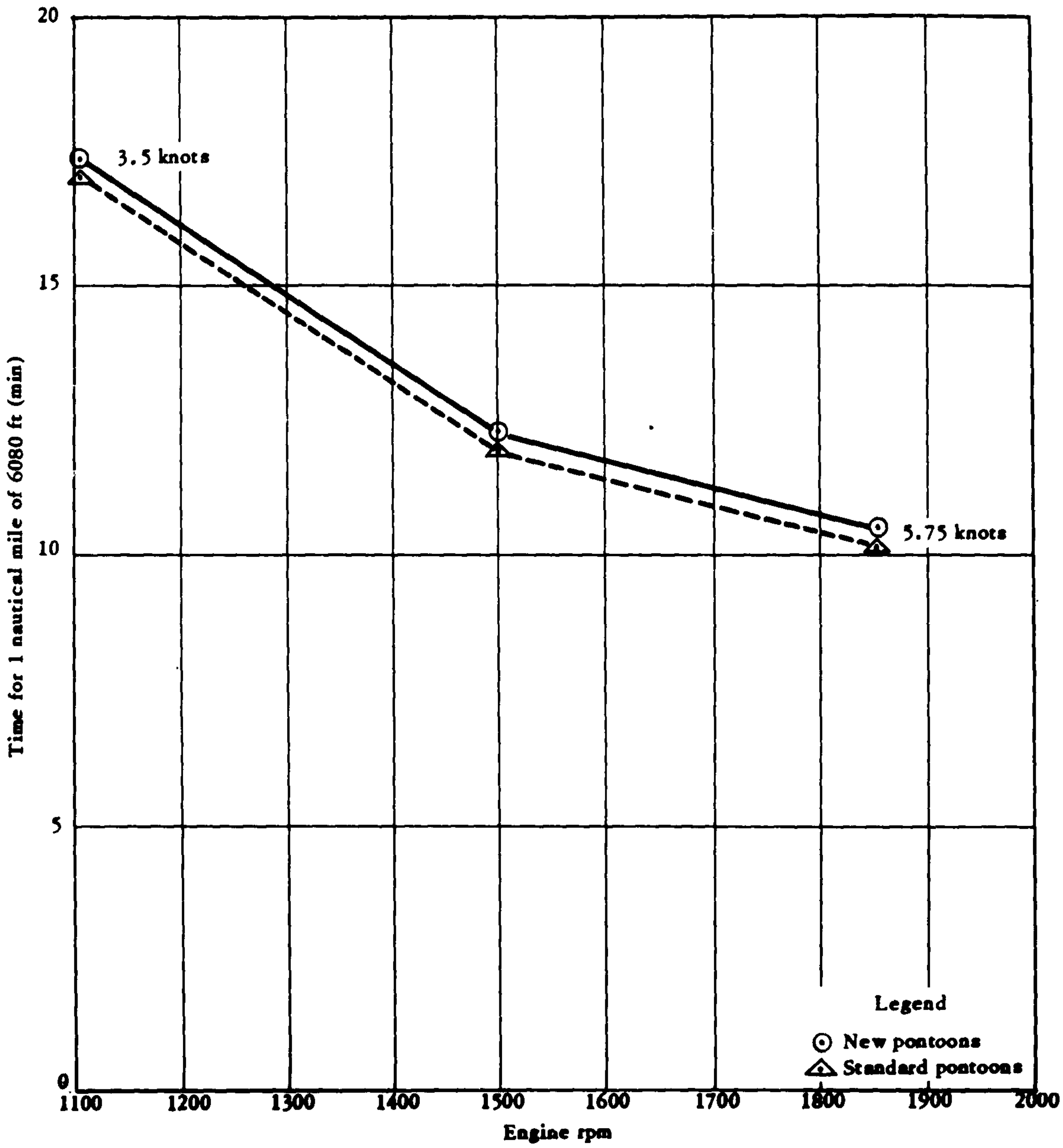

Figure 45. Speed vs rpm with no load on barge.

Figure 46. Hinged ramp for P-2 pontoon.

In the test as a ramp, it was found that the slope of the P-2 could be satisfactorily negotiated by all available vehicles except the extra-long-wheel-base vehicles such as the flat-bed truck, 4-ton 6 x 6, 4 DT, 172-in.-wheel-base, cab-protected and winch-rear-mounted, which is now obsolete. The hand-brake band on the drive shaft just touched the top edge of the angles as the truck went up the ramp. It was decided that an adapter slope (see Figure 47) could be put on the P-2 pontoon to make the slope entirely satisfactory for all types of vehicles (see Figures 48 and 49). This slope attachment is much less expensive than an extra or longer pontoon. Attachment is to be made by welding in position at the same time that the hinge and the cleats are welded on the ramp P-2 pontoons.

Figure 47. Hinged ramp with adapter slope for P-2 pontoon.

Figure 48. HD19 tractor boarding new design landing barge.

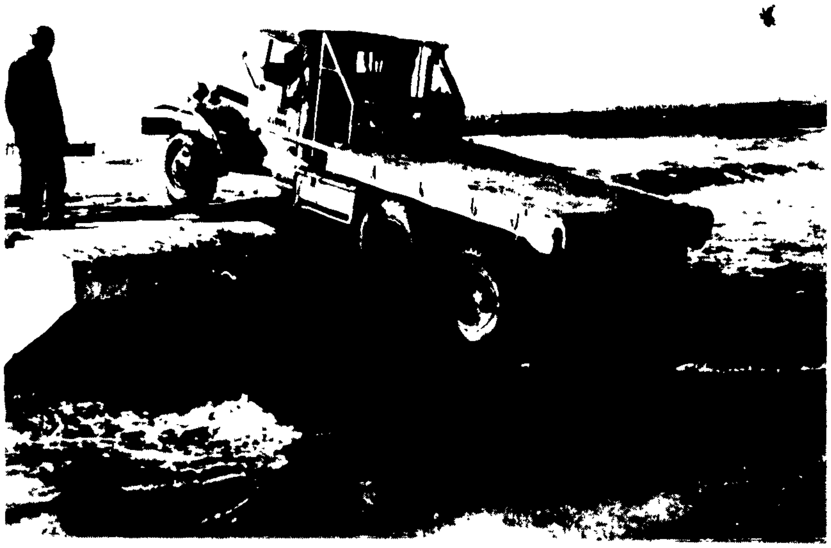

Figure 49. Four-ton, 6 x 6 truck with 172-in. wheel base loading on the new ramp and ramp adapter.

Side-Launching Tests

Launching tests were conducted to determine the structural adequacy for launching of the new design pontoons and angles and to provide a comparative basis with the present NL pontoon gear.[11] Side-launching tests were made from heights of the Class 542 and Class 1156 LSTs with an 02D propulsion unit mounted either over the outboard double angles or in the center of the outboard pontoon string.

Eight tests were made with a 3 x 12 ramp barge made of the new pontoon design (P-1, P-2, series angles). The barge was assembled with tie plates (formerly P-5), top and bottom, but without jewelry, tie rods, or links and pins (not included in new design). Two P-2 pontoons were inverted and utilized as a ramp on the bow of the barge.

First Launching. The barge was launched from the height of the Class 1156 LST, 6-ft 6-in., with and 02D unit mounted on the center of the outboard string. No special reinforcement was used to stiffen the structure. Upon impact with the water, the P-2 pontoon holding the propulsion unit broke loose from the top angles and resulted in failure of the bottom angles. Inspection showed that the A6 bolts holding the P-2 pontoon to the top angles failed and transferred the full bending load to the two bottom angles. Further inspection indicated that the failure of the A6 bolts was due to the extra length of the P-2, its straight-sloping bottom, and the lack of reinforcement necessary when launching from the 6-ft 6-in. height.[11] The T7A pontoon (7-ft 0-in.) has a curved bottom, which provides additional support to the angles upon contact with the water (see Figure 50).

Second Launching. For the second side-launching test, the 02D unit was moved to a position over the outboard double angles and the propulsion-unit base frame was extended in length to weld to the adjacent P-1 pontoon (see Figure 51). No additional reinforcement was used. The barge was launched from a height of 4 ft 7 in. Resulting damage consisted of a slight bending of the outboard pontoon angle.

Third Launching. The third test was made from a height of 5 ft 8 in. with an 02D unit mounted over the outboard double angle (see Figure 52). Reinforcing shear plates were added to the angles at the opening between the stern P-2 and P-1 pontoons (see Figure 53).

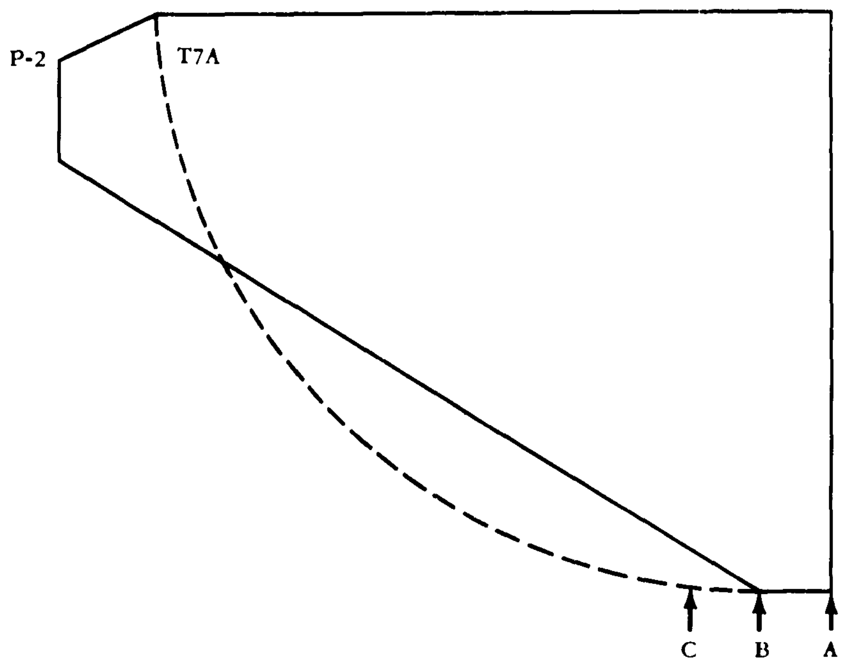

Figure 50. Sketch showing comparison of water-contact areas of present and new design pontoons.

Figure 51. View of extended propulsion unit foundation.

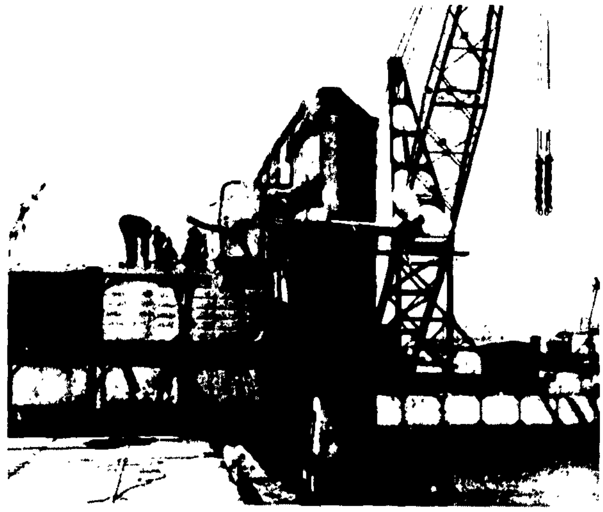

Figure 52. Barge ready for third launching.

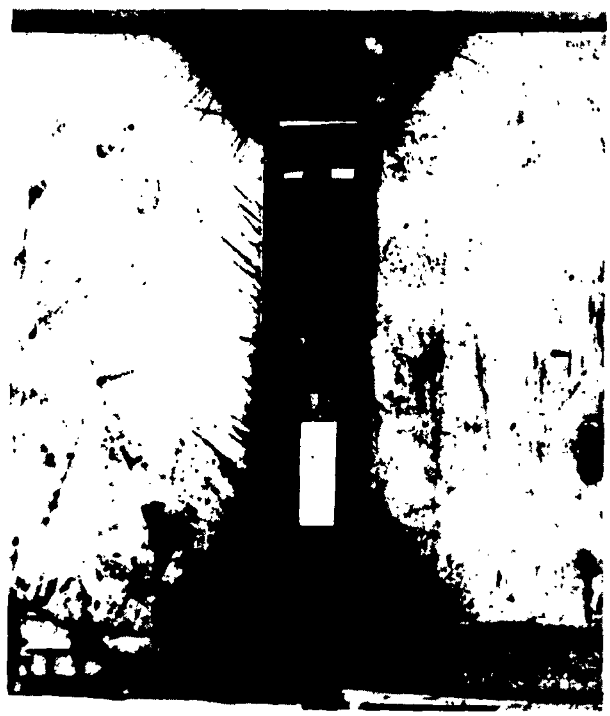

Figure 53. View of reinforcing shear plates.

These plates, installed during assembly of the angles, are 18 by 1/2 by 9 in. An accelerometer was mounted directly in front of the propulsion unit to measure the impact of the barge upon entering the water. No apparent damage to the barge was found after launching except the indentation of the pontoon bottom plates similar to that on the standard T6B.[11] Maximum deceleration was measured at approximately -35 g.

Fourth Launching. The barge without any further modification was launched again from a height of 4 ft 3 in. No failure occurred, and the only apparent damage was the further indentation of the pontoon bottom plates. The deceleration was measured at approximately -22 g.

Fifth Launching. The 02D unit was moved to the center of the outboard string (see Figure 54) and the barge was launched from a height of 4 ft 7 in.

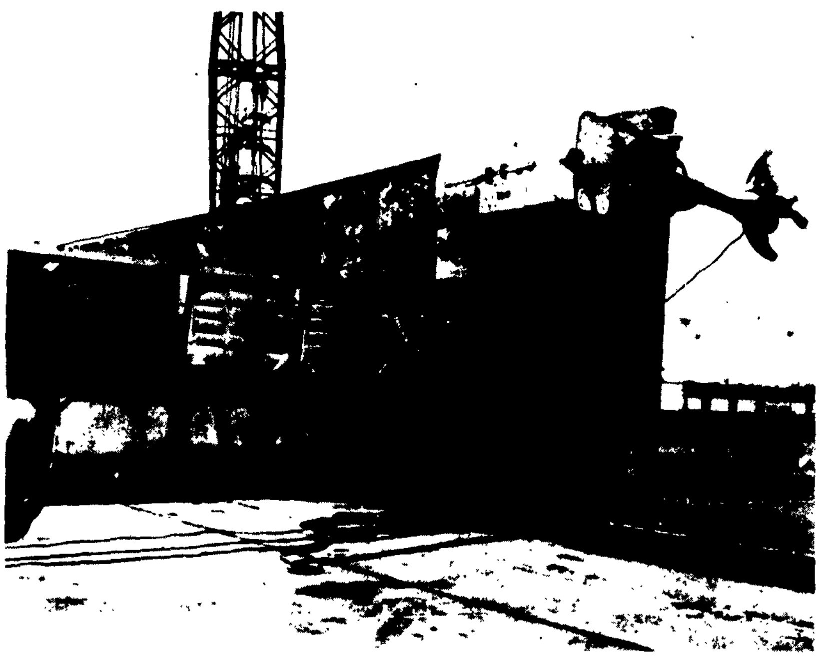

Figure 54. Barge ready for fifth launching.

The barge reinforcement was the same as in the third and fourth launchings: that is, the propulsion-unit base frame was extended to the adjacent P-1 pontoon, and one row of 18- by 1/2- by 9-in. shear plates was welded to the angles and pontoons. The deceleration of the barge was measured at -23 g. The outboard pontoon angle bent slightly (see Figure 55) at the second pontoon spacing from the stern of the barge, and the bottom plate of the P-1 pontoon in front of the propulsion unit failed at the bottom seam due to progressive indentation. However, the barge was still operable.

Figure 55. Close-up of slight bending of outboard and angle due to launching with propulsion unit on outboard string of barge.

Sixth Launching. The P-1 and P-2 pontoons used in the previous tests were disassembled, inverted, and reassembled into a 3 x 12 ramp barge. Inverting the pontoons provided new bottom plates for further launchings. In the new design pontoons, the deck plates and bottom plates are both fabricated from 3/16-in. plate. A second row of shear plates was provided to stiffen the pontoon angles at the point in which bending occurred in the fifth test. The 02D unit was mounted in the center of the outboard string, and the barge was launched from a height of 4 ft 7 in. No apparent damage occurred to the pontoon angles, but indentation of the pontoon bottom

plates was similar to that in previous launchings. Deceleration of the barge was measured at -30 g.

Seventh Launching. The barge without further modification was launched again from a 4-ft 7-in. height. Damage resulting from this launching included weld failures at four of the corners of the pontoons where the top plate joins the side plate, shear failure of two A6 bolts, and further indentation of the pontoon bottom plates. The barge was still operable. Inspection of the weld failures showed an insufficient amount of weld area in the seam to resist the repeated launching impacts. The nut receptacle was redesigned to strengthen it and also to simplify its fabrication (see Figures 56 and 57).

Eighth Launching. The barge without further modification was launched from a 6-ft 6-in. height, equivalent to Class 1156 LST. The 02D unit, as before, was mounted in the center of the outboard string. No apparent damage to the pontoon angles resulted. The indentation of the pontoon bottom plates was increased slightly as in the previous launchings.

It was concluded from the eight launchings that the new pontoon system is comparable to the present gear in strength to resist launching stress, but during all launchings it is necessary to use reinforcing plates to take the additional shear between the P-1 and P-2 pontoons imposed by the greater overhang of the P-2 pontoon. However, the shear plates will also be required on the present NL pontoons during launchings from the Class 1156 LST; therefore, these shear plates have been incorporated in the manufacture of the end pontoon angles to facilitate field-assembly.

Omission of jewelry, links and pins, and tie rods in assembly of the pontoons had no apparent adverse effect upon the structural strength of the barge during launching.

CONCLUSIONS

The advantages of the new pontoon gear designs as discussed in this report are as follows:

1. The P-1, P-2, and angle-system designs are equal to or stronger than the present designs.

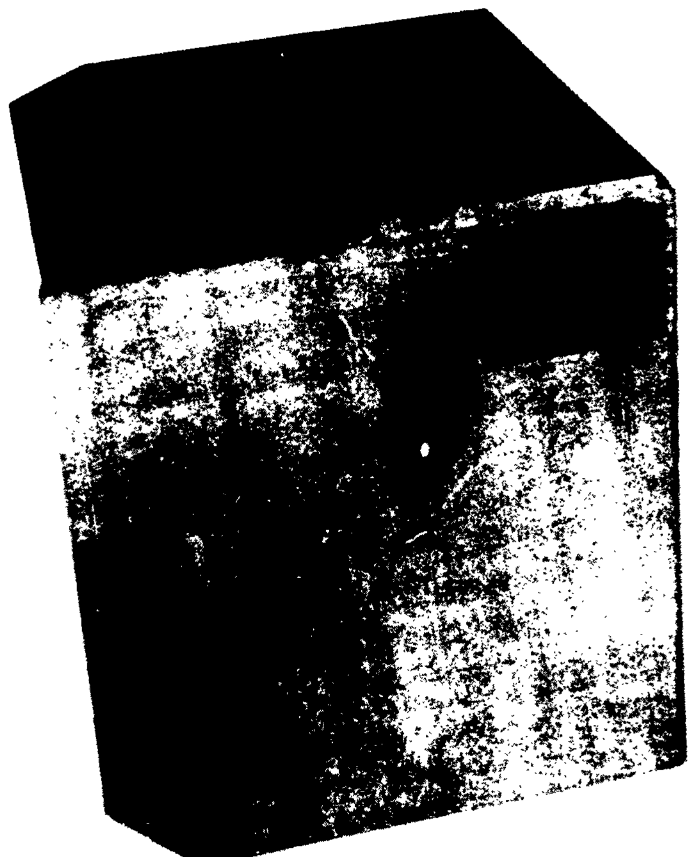

Figure 56. Final design of new nut receptacle, exterior view.

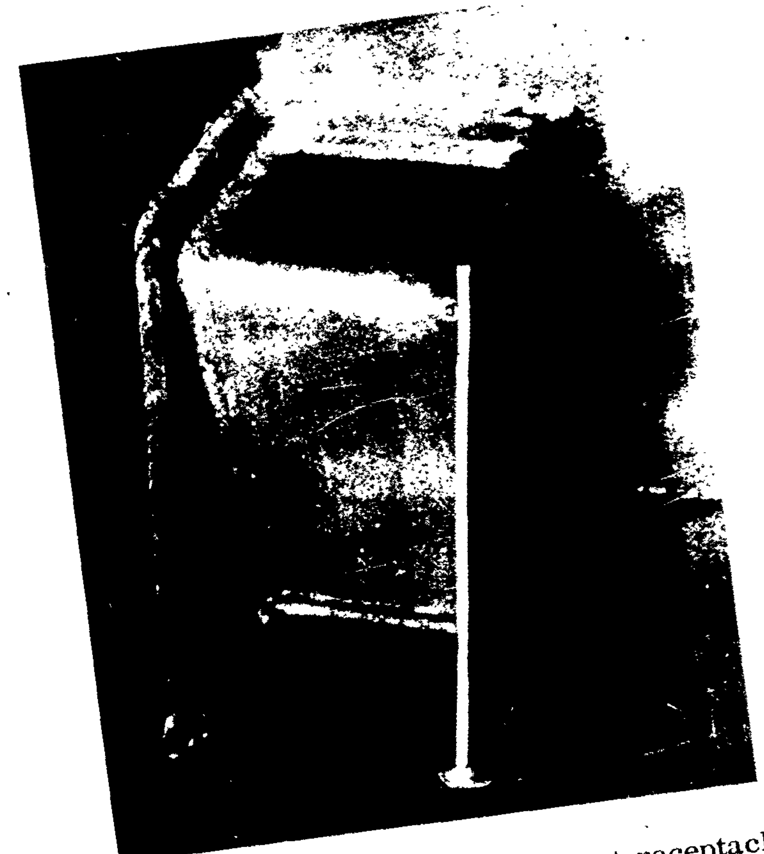

Figure 57. Final design of new nut receptacle, interior view.

2. The P-1, P-2, and angle system are simple to fabricate and require less tooling and manpower than present gear.

3. The P-1, P-2, and angle system are less expensive (see Appendix I), resulting in savings of approximately $100.00 per assembled pontoon.

4. Omission of jewelry and links and pins and use of the loose, flanged nut have reduced the assembly time approximately 25 per cent.

5. No proprietary item is used in the new design.

6. Fewer parts are required for the new design, making procurement, stock piling, and shipment simpler.

7. Accessory items which are lighter in weight and less costly can be developed.

Based upon the complete study, it is concluded that the features of the new design cannot feasibly be incorporated into a design which would be interchangeable with the present design. Further, it is not considered necessary that any new design be interchangeable, as a change-over to a new design could be smoothly and economically accomplished by using up present stocks while preparing adequate instructions, plans, specifications or accessories, and manuals for use of the new gear. A small number of new assemblies can also be issued for training purposes.

RECOMMENDATIONS

It is recommended that:

1. A new 3 x 12 ramp landing barge of P-1, P-2, and a series angle system be procured by the Laboratory and shipped to ACB No. 1 for field test, including disassembly and assembly, for a period not to exceed two months.

2. Upon completion of the tests at ACB No. 1, any deficiencies should be corrected and enough of the new gear should be procured by the Laboratory to make two causeways and one 3 x 12 barge.

3. The two causeways and barge be evaluated by the Naval Amphibious Test and Evaluation Unit, Little Creek, Norfolk, Virginia, or at ACB No. 1, Coronado, California.

4. The design be modified and improved as dictated, based upon the results of this field evaluation.

5. Accessory gear be developed at the Laboratory to make the new design complete.

6. A pontoon manual be prepared on the new gear.

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APPENDIX I

COST COMPARISON BASED ON LARGE SCALE PROCUREMENT

		Present design*	New design**
Standard pontoon (T6B or P-1)		$270.00	$225.00
Bow or stern pontoon (T7A or P-2)		390.00	350.00
Ramp pontoon			
T8 or P-2		375.00	
T11 or P-2		413.00	
	Total	$788.00	350.00
Angles, avg value of 6-in. angle (cost/ft)		4.50	2.20
Ramp (2)		611.00	300.00
Jewelry, per pontoon (8 sets)		15.44	...
Link and pin, each		1.12	...
1-1/2 in. nut, per pontoon (8)		4.00	4.80

*Prices based on BUDOCKS Catalog price - July 1954.

**Estimates based on savings and discussions with manufacturers during July 1954.

APPENDIX II

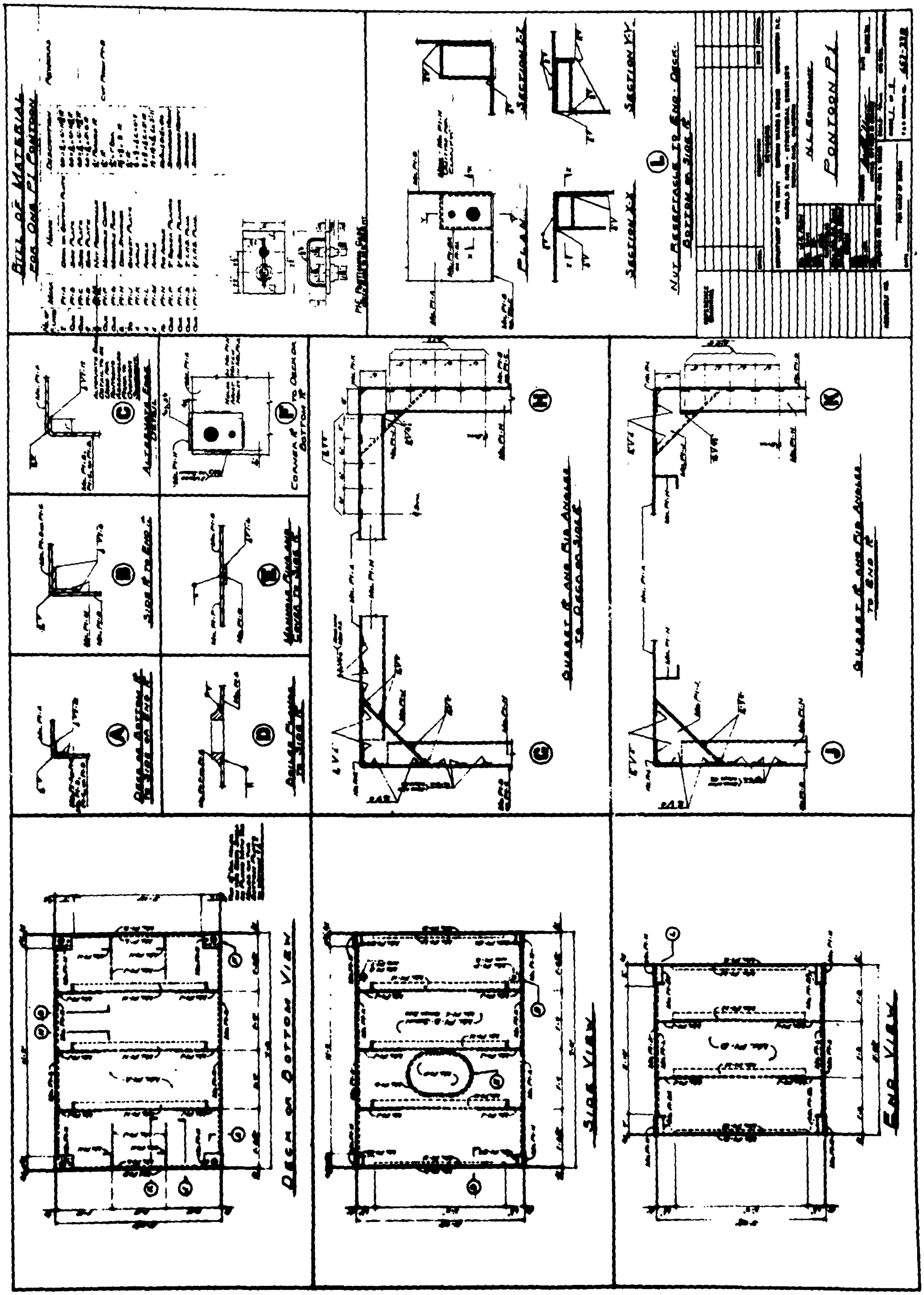
ACCESSORY ITEMS AFFECTED BY BOLT SPACING

Mark no.	Description	Stock no.
A40	Hinge, right hand	YS12-H-1100-50
A41	Hinge, left hand	YS12-H-1025-50
A61L	Bracket, stabilizer	YS12-B-1967-150
A61R	Bracket, stabilizer	YS12-B-1967-170
A62	Connection, strut	YS12-C-2029-50
A77	Plate, tie	Y12-P-2761
A83L	Bracket	Y12-B-1967-155
A83R	Bracket	Y12-B-1967-175
A104	Bitt, all purpose	Y12-B-1607-25
H4	Hanger, pipe	Y45-H-719-75
H5	Hanger, pipe	Y45-H-719-85
H17F	Hinge, heavy duty	YS12-H-995-50
H17M	Hinge, heavy duty	YS12-H-1080-50
HB3L	Bar hinge (plate 8- by 1/2- by 8-in.)	Y12-H-897-100
HB3R	Bar hinge (plate 8- by 1/2- by 8-in.)	Y12-H-897-200
HB4	Plate, top	Y12-P-2761-350
HB5	Plate, top	Y12-P-2761-340
GV8	Guard, angle	Y12-6-1915
M60	Angle	Y12-A-565-20
M115	Connection, causeway	YS12-C-2020-2022
OB7	X-B assembly	C9-B-140-270
OB12	X-B assembly	C9-B-140-170
P-5	Plate, shear	YS12-P-2710-20
P-5B	Plate, tie	YS12-P-2760-215
P-5U	Plate, tie	YS12-P-2761-250
P-39	Plate, filler	YS12-P-2714-25
PB4	Angle, ramp barge	YS12-A-564-60
SC25	Bracket	YS12-B-1940-300
CF3	Base for canvas tent poles	C-245-990-150

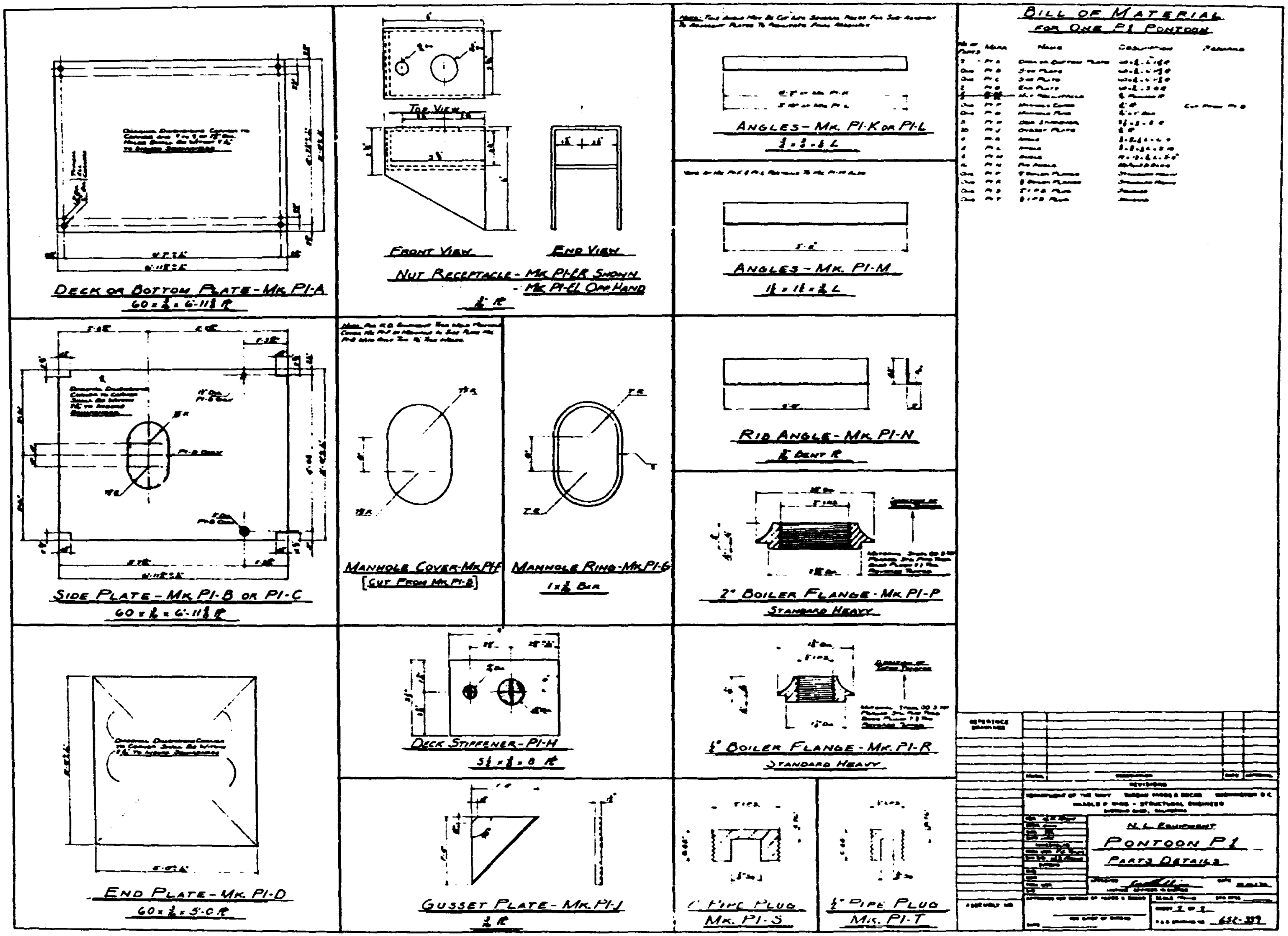
Filler K used on A40 and A41

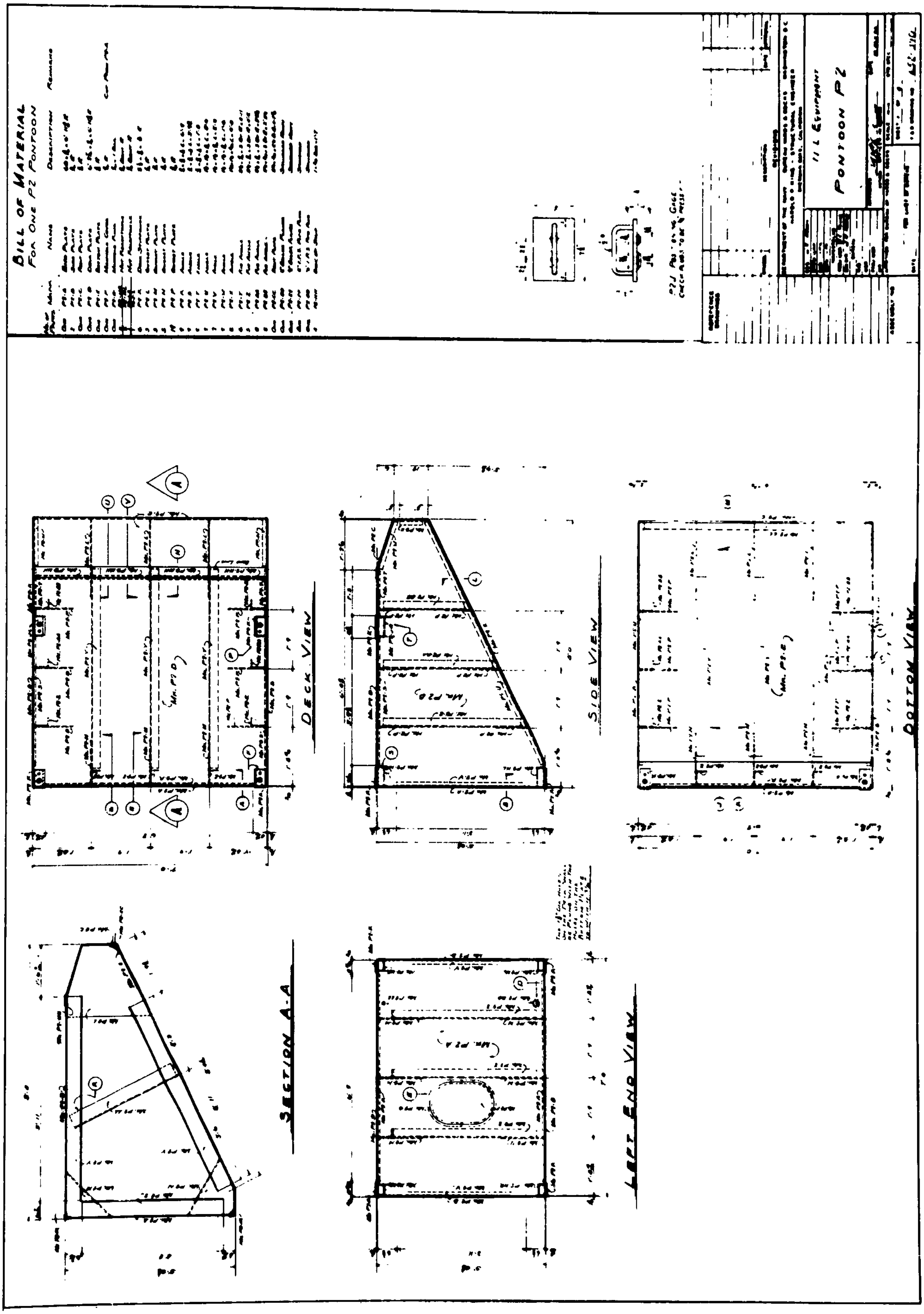
APPENDIX III

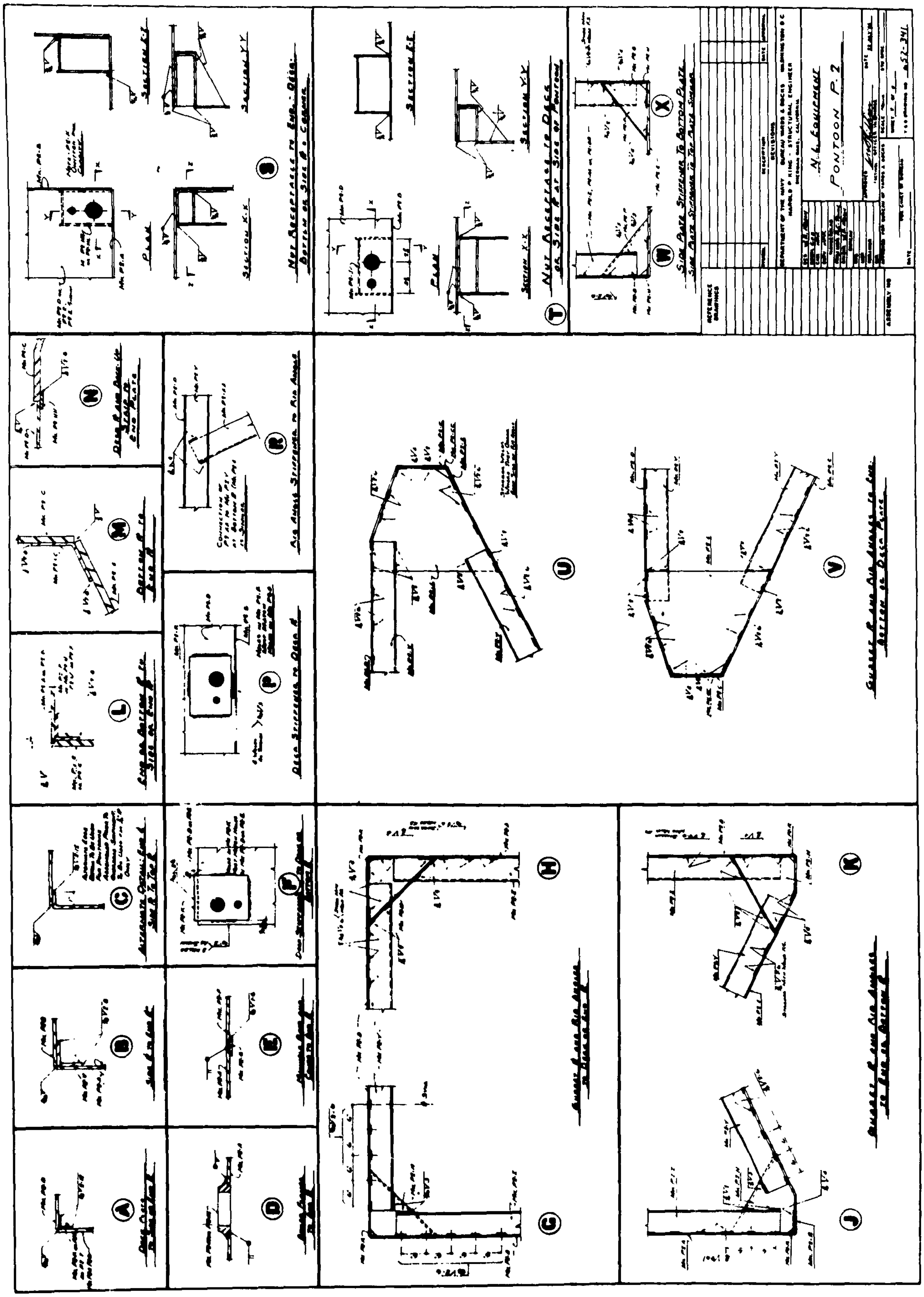
Y&D Drawing No.	Title
652, 338	New P-1 Pontoon
652, 339	New P-1 Pontoon Parts Details
652, 340	New P-2 Pontoon
652, 341	New P-2 Pontoon
652, 342	New P-2 Pontoon Parts Details
652, 343	New P-2 Pontoon Parts Details
652, 344	New Pontoon Angle Series System for P-1 and P-2 Pontoons

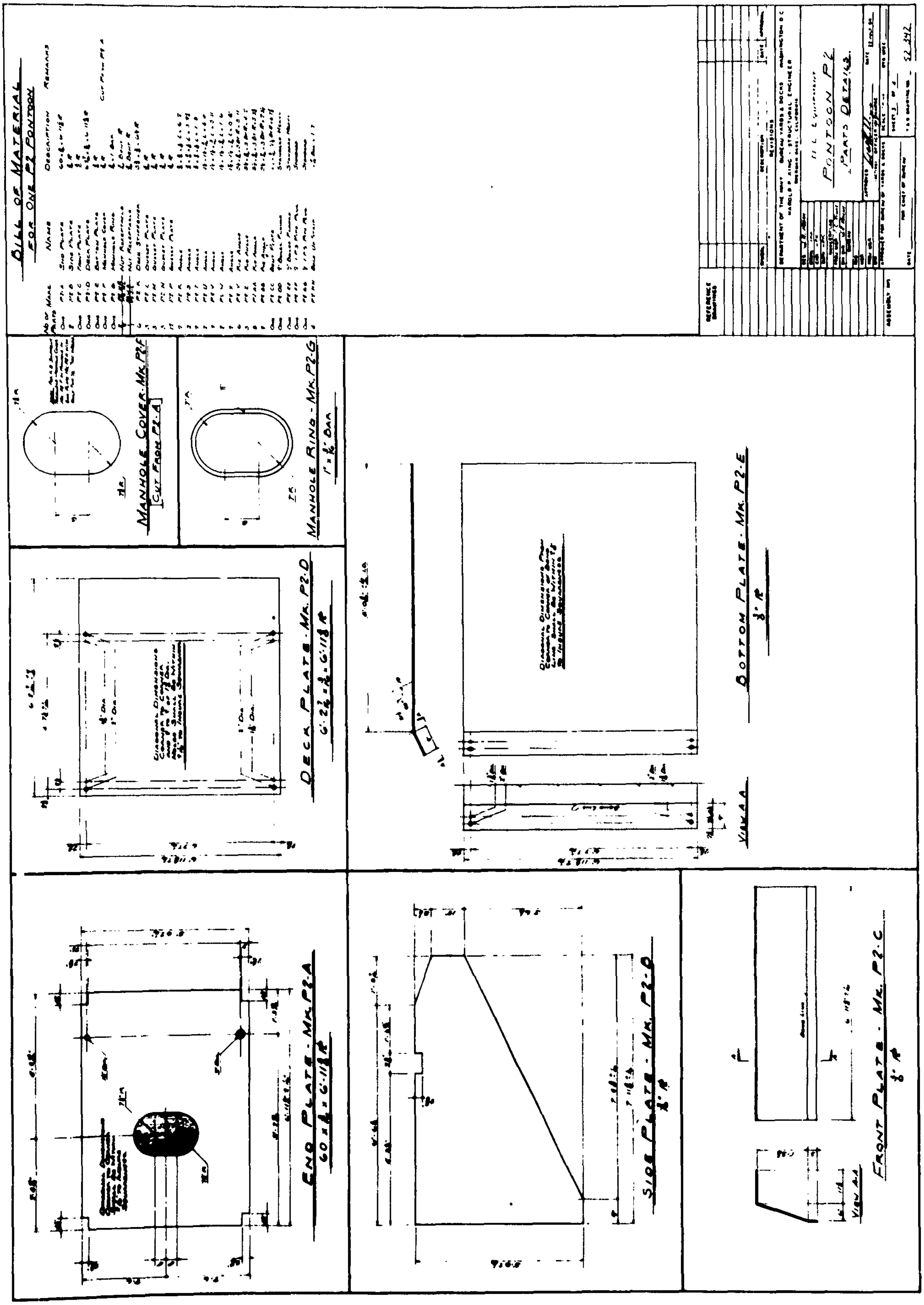


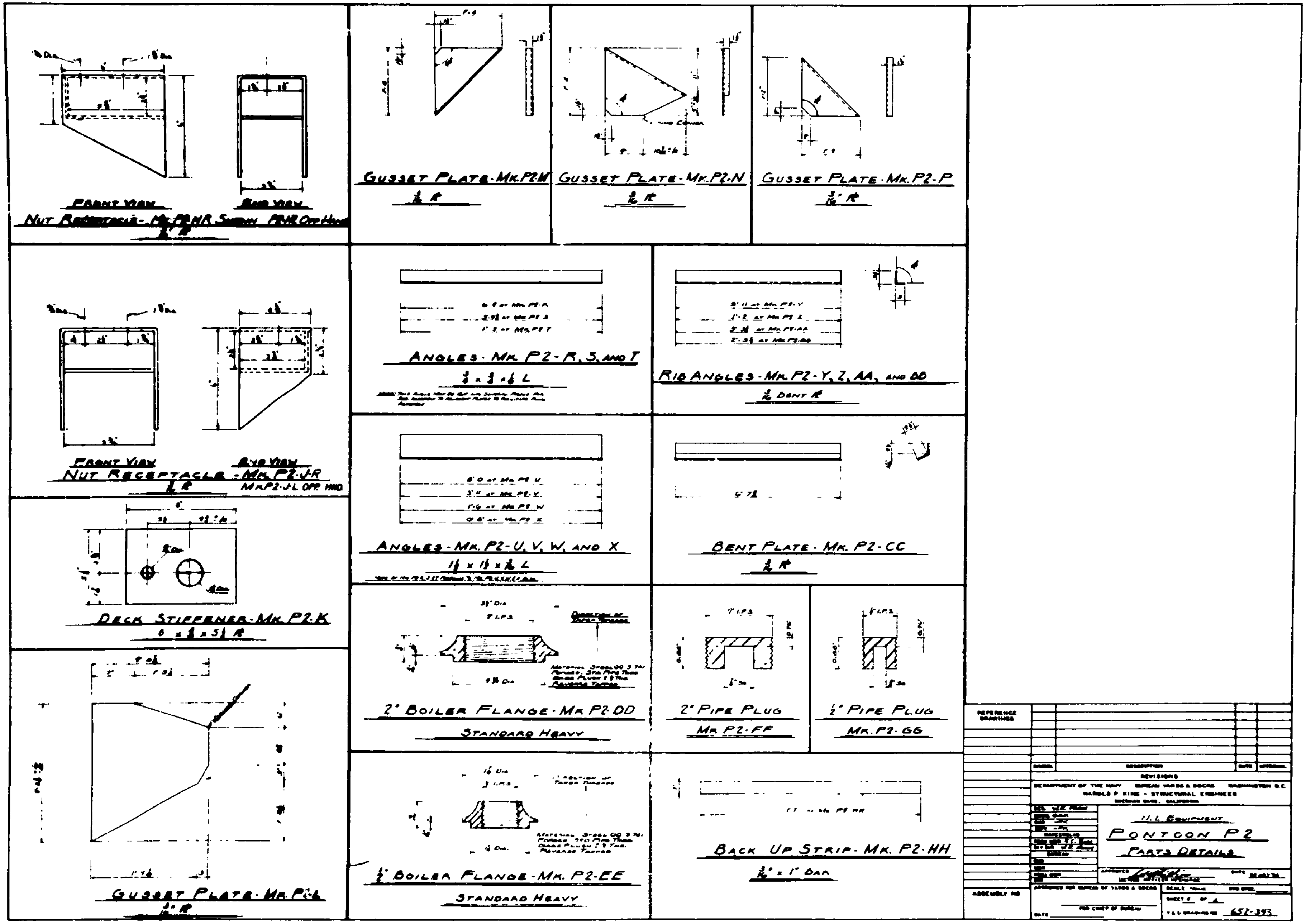
BILL OF MATERIAL FOR ONE P1 PONTOON
SECTION Z-Z
SECTION Y-Y
SECTION X-X
PLAN
NUT RECEPTACLE TO END-DECK-BOTTOM OR SIDE
PONTOON P1
ALTERNATE END DETAIL
CORNER TO DECK OR BOTTOM
DECK OR BOTTOM TO SIDE OR END
SIDE TO END
GUSSET AND RIB ANGLES TO DECK OR SIDE
GUSSET AND RIB ANGLES TO END
DECK OR BOTTOM VIEW
SIDE VIEW
END VIEW

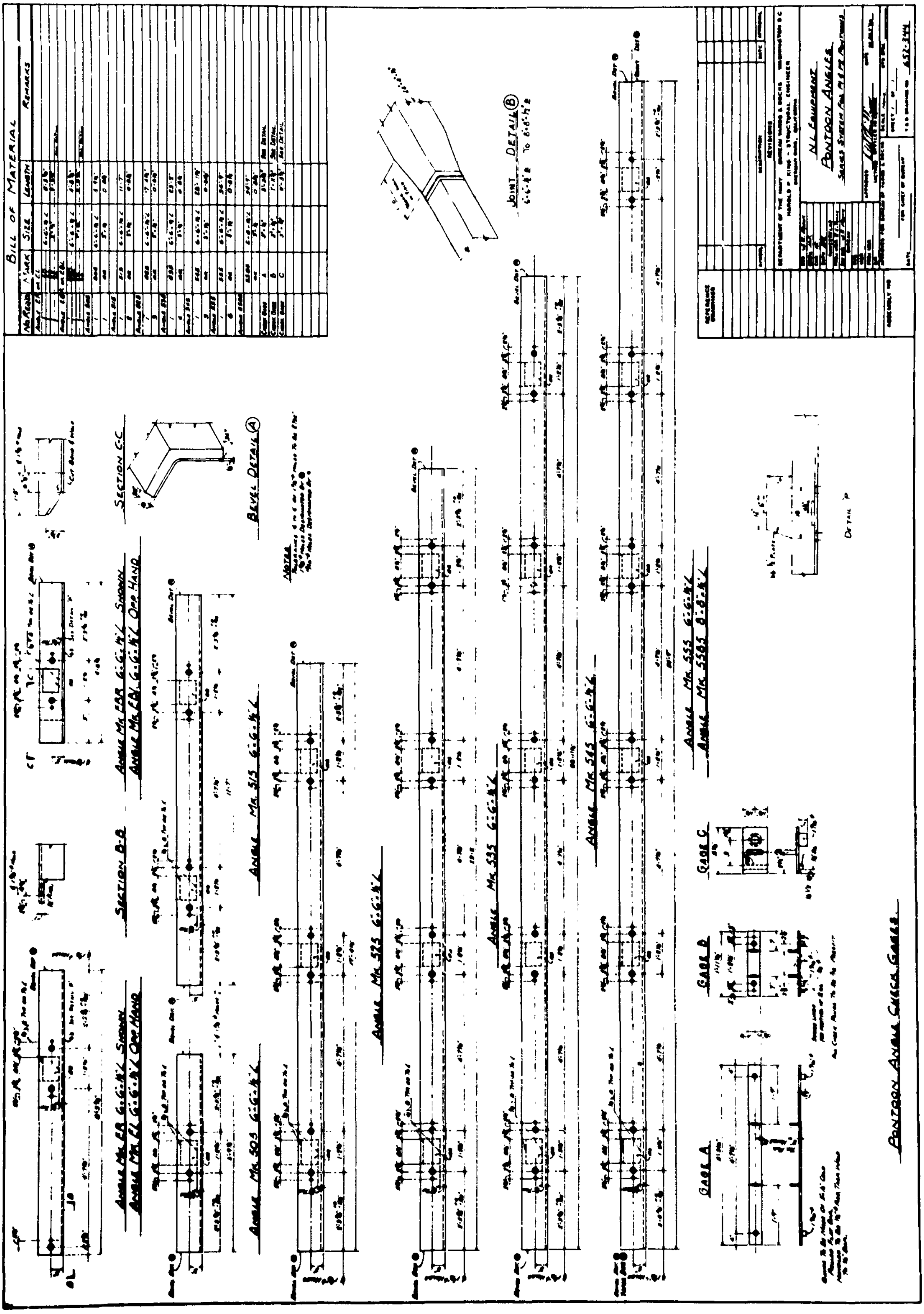

DECK OR BOTTOM PLATE - MK. P1-A
60 x 1/2 x 6-11 3/8 R
FRONT VIEW
END VIEW
TOP VIEW
NUT RECEPTACLE - MK. P1-ER SHOWN
- MK. P1-EL OPP. HAND
ANGLES - MK. P1-K OR P1-L
ANGLES - MK. P1-M
SIDE PLATE - MK. P1-B OR P1-C
60 x 1/2 x 6-11 3/8 R
MANHOLE COVER - MK. P1-F
[CUT FROM MK. P1-B]
MANHOLE RING - MK. P1-G
RIB ANGLE - MK. P1-N
2" BOILER FLANGE - MK. P1-P
STANDARD HEAVY
END PLATE - MK. P1-D
60 x 1/2 x 5-0 R
DECK STIFFENER - P1-H
GUSSET PLATE - MK. P1-J
1/2" BOILER FLANGE - MK. P1-R
STANDARD HEAVY
1" PIPE PLUG
MK. P1-S
1/2" PIPE PLUG
MK. P1-T
BILL OF MATERIAL
FOR ONE P1 PONTOON
REVISIONS
N. L. EQUIPMENT
PONTOON P1
PARTS DETAILS


BILL OF MATERIAL
FOR ONE P2 PONTOON
DECK VIEW
SIDE VIEW
BOTTOM VIEW
SECTION A-A
LEFT END VIEW
PONTOON P2




BILL OF MATERIAL
FOR ONE P2 PONTOON
MANHOLE COVER-MK. P2-F
CUT FROM P2-A
MANHOLE RING-MK. P2-G
DECK PLATE-MK. P2-D
BOTTOM PLATE-MK. P2-E
END PLATE-MK. P2-A
FRONT PLATE-MK. P2-C
PONTOON P2
PARTS DETAILS


FRONT VIEW
END VIEW
NUT RECEPTACLE - MK. P2-HR SHOWN P2-HL OPP. HAND
GUSSET PLATE - MK. P2-M
GUSSET PLATE - MK. P2-N
GUSSET PLATE - MK. P2-P
FRONT VIEW
SIDE VIEW
NUT RECEPTACLE - MK. P2-JR
MK. P2-JL OPP. HAND
ANGLES - MK. P2-R, S, AND T
RIB ANGLES - MK. P2-Y, Z, AA, AND BB
ANGLES - MK. P2-U, V, W, AND X
BENT PLATE - MK. P2-CC
DECK STIFFENER - MK. P2-K
2" BOILER FLANGE - MK. P2-DD
STANDARD HEAVY
2" PIPE PLUG
MK. P2-FF
1/2" PIPE PLUG
MK. P2-GG
GUSSET PLATE - MK. P2-L
1/2" BOILER FLANGE - MK. P2-EE
STANDARD HEAVY
BACK UP STRIP - MK. P2-HH
REVISIONS
DEPARTMENT OF THE NAVY BUREAU YARDS & DOCKS WASHINGTON D.C.
HAROLD P. KING - STRUCTURAL ENGINEER
N.L. EQUIPMENT
PONTOON P2
PARTS DETAILS
652-343


BILL OF MATERIAL
ANGLE MK. ER 6·6·½∠ SHOWN
ANGLE MK. EL 6·6·½∠ OPP HAND
SECTION B-B
ANGLE MK. EAR 6·6·½∠ SHOWN
ANGLE MK. EAL 6·6·½∠ OPP HAND
SECTION C-C
BEVEL DETAIL (A)
ANGLE MK. 505 6·6·½∠
ANGLE MK. 515 6·6·½∠
NOTES
ANGLE MK. 525 6·6·½∠
ANGLE MK. 535 6·6·½∠
ANGLE MK. 545 6·6·½∠
ANGLE MK. 555 6·6·½∠
ANGLE MK. 555S 8·8·½∠
JOINT DETAIL (B)
GAGE A
GAGE B
GAGE C
DETAIL P
PONTOON ANGLE CHECK GAGES
N.L. EQUIPMENT
PONTOON ANGLES
652-344

Naval Civil Engineering Research and Evaluation Laboratory. Technical Memorandum M-106.
DEVELOPMENT OF AN IMPROVED PONTOON SYSTEM, by W.R. Mason and R.C. Towne.
3 August 1955. 63 p. illus. UNCLASSIFIED

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1. Pontoons.
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II. Towne, R.C.
III. NY 113 001-6
IV. NY 112 006

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